

AGRICULTURAL RESEARCH INSTITUTE
PUSA

Nature,
August 15, 1925]

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME CXV

JANUARY, 1925, to JUNE, 1925

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

London
MACMILLAN AND CO., LIMITED
NEW YORK: MACMILLAN COMPANY

[*Nature*,
August 15, 1925



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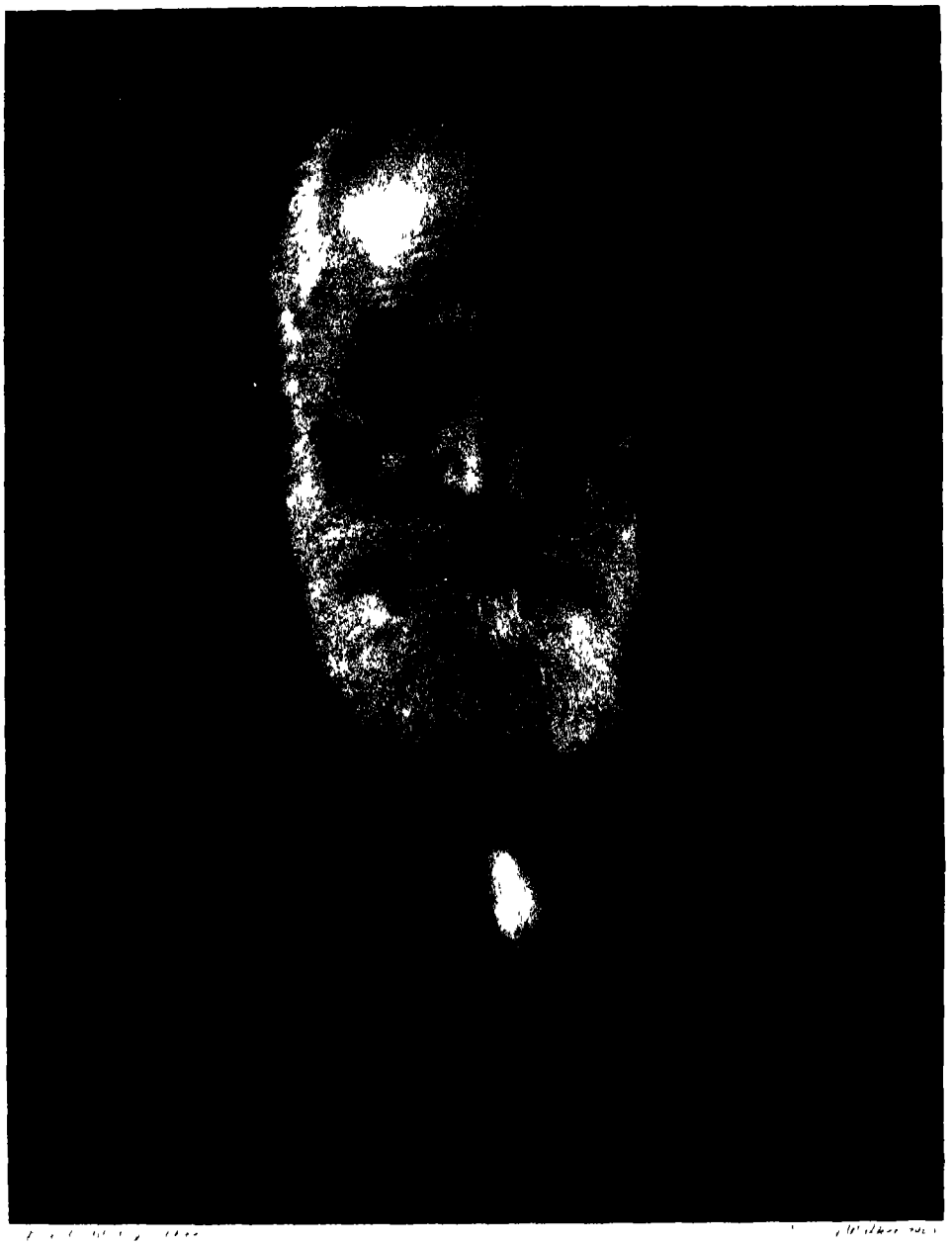
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Supplements should be bound with the numbers in which they appear.

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*



I. P. Pavlov

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

SATURDAY, JANUARY 3, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2879, VOL. 115]

Scientific Worthies.

XLIII.—Ivan Petrovitch Pavlov.

THE eminent physiologist, whose portrait is published to-day in continuation of the NATURE series of Scientific Worthies, was born on September 14, 1849, in the district of Rjásan in Russia. He was the son of the village priest. After receiving some education at a theological seminary, he determined to devote himself to science and entered the University of St. Petersburg. On the completion of his course in general science, he took the medical course at the Military Medical Academy, receiving his qualification to practise in 1879. At that time Botkin, the clinician, maintained several younger men as scientific assistants to carry on research in connexion with his wards, and Pavlov, after qualification, became his assistant, with special charge of the work involving animal experimentation. In 1883 he obtained the M.D. of St. Petersburg, and in 1884 was appointed privat-dozent in physiology. Immediately afterwards, he went for two years to Germany to work under Ludwig and under Heidenhain. In 1890 the Institute of Experimental Medicine was built at the cost of Prince Oldenburg, von Anrep being appointed its first director, and in 1891 Pavlov became director of the physiological department of the Institute. In 1897 he was called to the professorship of physiology in the Military Medical Academy, without, however, giving up his post in the Institute of Experimental Medicine, and in 1907 he became one of the four scientific members of the St. Petersburg Academy and obtained in this way another laboratory under his charge. His work from this time forward, therefore, was carried on in three laboratories, his own personal experiments, however, being confined to the Institute of Experimental Medicine, the other two laboratories being in charge of assistants, though the work at all three places was inspired directly by Pavlov and subject to his continual oversight and criticism.

Pavlov married quite young, his wife being a teacher in a school and herself the daughter of a village priest. He has had four children, one of whom is a well-known physicist who has worked in Cambridge under Sir Joseph Thomson and is now professor of physics in Leningrad.

Pavlov's scientific work falls easily into three well-defined chapters, though there is a certain leading idea which has guided him throughout and characterises all the researches for which he has been responsible. He set himself from the beginning to elaborate the analytic method of research Each function of the body has to be studied in relation to other functions as well as to external conditions, and the exact part played by each condition determined by artificial removal or arousal of the condition *while keeping the other conditions constant.* Up to Pavlov's time the necessity for this last precaution had not been properly appreciated or systematically carried out. Physiologists had been content to study functions in isolated organs or in animals in a profoundly abnormal condition, either through the action of anæsthetics or under the effects of discomfort or pain Pavlov realised that these disturbing factors, namely, anæsthetics, pain and discomfort, must be eliminated before the part played by excitation of a nerve, for example, under normal conditions could be appreciated, or proper value given to the results of operative procedure.

We see the beginning of these ideas in the first chapter of Pavlov's scientific activities, those connected with the physiology of the circulation. The first papers published by him in German appeared in 1878–1879 and dealt with the normal regulation of the blood pressure in the dog. In these experiments, Pavlov trained a dog to allow the insertion of a cannula in a small superficial artery on the inner side of the knee-joint and to remain quiet while the blood pressure was recorded. In such an animal he was able to study the effects of digestion as well as of drinking large quantities of fluid in the form of broth. He found that neither of these procedures produced any change in blood pressure amounting to more than about 10 mm. of mercury. In 1887 he published two papers on the efferent nerves of the heart, the first based on work carried out in St. Petersburg, while in the second paper he described the results of testing his previous findings with the use of Stolnikow's apparatus for measuring the output of the isolated heart. This research was carried out while he was studying in Ludwig's laboratory.

The work, however, for which Pavlov is best known is that connected with the physiology of digestion. Here the introduction of new methods devised to fulfil the conditions laid down by him at the beginning of his career enabled him to rewrite this chapter in physiology. At the present time our whole idea of the course of digestion is based upon Pavlov's discoveries. This work would have been impossible but for Pavlov's marvellous skill as an operator. Already in 1879 he had published three papers on the pancreatic secretion, and one of these described a new method which he had elaborated for making a pancreatic fistula, but from 1888 to 1900 all his activities were devoted to the problems of digestion In 1888 he showed that the vagus nerve was the secretory nerve to the pancreas, and also was able to explain why previous observers had failed to obtain any results from stimulating this nerve. In 1889 one of his pupils published a preliminary note in the *Centralblatt fur Physiologie* on the secretion of the gastric juice.

It is in this note that we first find a description of Pavlov's method for obtaining pure gastric juice. The animal was provided with fistulous openings into the stomach and also into the œsophagus. Such an animal had to be kept alive and in good condition by the introduction of food through the lower end of the œsophagus or directly into the stomach. It was essential, according to the rules laid down by Pavlov, that the animal should be kept in good condition, free from pain or even from discomfort. After such an operation these objects can only be attained by devoting extreme care to feeding the animals. At that time there were no proper facilities for the care of animals, and this work could not be entrusted to an ordinary laboratory attendant. Pavlov, therefore, after operating on his dogs, took them home, and here in his small flat they were looked after by his wife, with the children.

The success of Pavlov's experiments was entirely due to the devoted care which was given to the animals. In a dog provided with an œsophageal and a gastric fistula Pavlov found that, within a few minutes of giving the animal food, there was a copious flow of juice through the gastric fistula. This was known as "sham feeding," and the secretion was proved by him to be due to the effect of appetite and was therefore named by him "psychical secretion." It could be aroused not only by eating but also by the mere sight of food, though it ceased as soon as the animal realised that the food was not going to be given to it. Pavlov proved also that the efferent channel for the psychical reflex was by the vagus nerves and that the secretion was stopped by section of the vagus nerves and was aroused by artificial stimulation of the peripheral end of a cut vagus nerve.

From 1892 to 1897 a whole array of papers on the physiology of digestion appeared in the *Archives des Sciences Biologiques*, so that Pavlov's discoveries became known to his colleagues in other countries. In 1897 a collected account of his work was brought out in German

and in French under the title "Die Arbeit der Verdauungsdrüsen." A little time later an English translation appeared from the German edition by Prof. W. H Thompson. In 1904 Pavlov was awarded the Nobel Prize for medicine for his work on the physiology of digestion. By this time, however, Pavlov's methods had become widely known through the agency of his pupils, many of whom had acquired sufficient operative skill to carry out the difficult operations which had previously depended on Pavlov himself, so that the work could be continued on the lines laid down in Pavlov's laboratory. At the date of the award of the Nobel Prize, Pavlov had practically given up a direct personal interest in the subject of digestion and had taken up another subject.

Hitherto, our methods of investigating the functions of the cerebral hemispheres have been extremely unsatisfactory. We may study the effects of removal or excitation of definite areas in the cortex, but the results of such experiments have given rise to conflicting opinions as to their significance We know, for example, that in most mammals all the apparatus necessary for immediate motor reactions is contained in the parts below the hemispheres, and it is difficult to judge from the presence or absence of a response to some sensory stimulation after removal of portions of the cortex whether the cortical deficiency is really responsible for the effects, if any, observed More stress has been laid, therefore, on observations on man, where lesions have been produced in the cortex by disease or injury. Here, however, there is a tendency to abandon the pure physiological method, and in our arguments we are apt to jump continually from the objective to the subjective method and vice versa.

Physiology is the objective examination and analysis of the behaviour of an animal under all manner of conditions. Up to the time when Pavlov began his researches, we lacked such objective physiological methods as would do for the analysis of the functions of the cortex the same services that had been rendered by physiological method in the hands of Sherrington for the analysis of the spinal reflex functions, or which have recently been used by Magnus and others in the investigation of the manner in which equilibrium is maintained or restored. We know that the cerebral cortex is what has been called the educatable part of the central nervous system: it is responsible for reactions which have been learnt in the course of the individual's existence. In the higher animals, especially in man, these learnt reactions overlie and take precedence of most of the immediate reflexes carried out by the spinal cord and brain stem, so that almost the whole of a man's behaviour throughout his adult life is carried out by a series of reactions to the environment for which the cortex is primarily responsible. An analysis of the manner in which this complex never-ending series of reactions is built up so as to form an individual with his peculiar reactions, must begin with the simplest.

Pavlov conceived the ingenious idea of using the appetite reactions, with which his previous twenty years' work had made him so familiar, as an objective sign of cortical reactions. It is well known that introducing acid or other gustatory substances into the mouth of a dog evokes a flow of saliva, and the intensity of the reaction can be measured by providing the animal with a salivary fistula and counting the drops or measuring the amount of saliva which is secreted in response to a given stimulus. Such a reaction is called by Pavlov an *unconditioned reflex* If, however, some other kind of stimulus, for example, ringing a bell, be associated for some time—weeks or even days—with the presentation of food or the introduction of acid into the mouth, the associated stimulus after a time is sufficient to evoke a flow of saliva without the presentation of food This reaction was called by Pavlov a *conditioned reflex* It is dependent on the laying down—the "education"—of new paths in the cortex This method of establishing new reflexes has been used by him for investigating the higher functions of the cortex, the conditioned salivary reflex being employed as the unit sign of cerebral activity, just as the movements of flexion or extension of a limb have been used as a test for spinal function. Instead of studying the physiology of the eye, the ear, and other superficial organs, in its purely subjective aspect, we can use any of these sense organs for the establishment of a conditioned reflex or reflexes. We can proceed, untrammelled by psychological preconceptions, to study the behaviour of animals in its highest aspect by purely objective methods.

A preliminary account of his researches was given by Prof. Pavlov in the Huxley Lecture which he delivered at Charing Cross Hospital on October 1, 1906. Since that time a very large number of researches carried out by this method have been published by Pavlov and his pupils, but almost entirely in Russian, so that they are very little known, except in broadest outline, in Great Britain and other countries. It is satisfactory to learn that he is now engaged in writing a collected account of these researches which, when translated, will make them available for the instruction of physiologists, as well as psychologists, throughout the world, and will enable us to attack by this new method and with a greater hope of success the function of the cerebral hemispheres, which is indeed the capital question in the physiology of man.

Pavlov was elected a foreign member of the Royal Society in 1907 and was awarded the Copley Medal in 1915.

E. H. STARLING.

Science and the Community.

IN an address delivered in connexion with the recent celebration of the centenary of the Franklin Institute, Philadelphia, and published in the Journal of the Institute for November, Dr. A. D Little directs attention to the curious anomaly that although all the distinctive features of modern civilisation are due to discoveries made by scientific men, yet in no country in the world is the governing and directing power in their hands. It is an interesting but very familiar fact. Dr Little, in his own engaging and energetic style, is only saying over again something that has been said by various eminent men of science for very many years. It is a fact that not more than 100,000 men throughout the world are creatively engaged in the advancement of science, and yet a list of those features of our modern civilisation which distinguish it from the middle ages would show that they are dependent upon these men and could not continue without them Nevertheless, the opinions of scientific workers are not asked on the direction of the civilisation that their kind have built up, nor are their services considered worthy of any special reward.

At first sight this state of affairs appears to be fantastic. Dr. Little vividly illustrates the astonishing disparity between service and award in a modern community:

"It is incomparably more profitable to draw The Gumps for a comic supplement than to write 'The Origin of Species.' There is more money in chewing gum than in relativity. Lobsters and limousines are acquired far more rapidly by the skilful thrower of custard pies in a moving-picture studio than by the no less skilful demonstrator of the projection of electrons. The gate receipts of an international prize fight would support a university faculty for a year"

All this is, of course, quite true, but the implications are a little doubtful. Is it suggested that Einstein should be paid more than the custard-pie expert, or that the expert's income should be reduced below the level of that of a professor of physics? The custard-pie expert is paid directly by the public; for the amusement he gives them they pay him an immense income. But the professor of physics does not amuse them, for the most part he bores them, and they are in no position to understand that his work is of real importance to their lives and to the lives of their children.

It seems that Dr. Little is really finding fault with the cultural level of modern communities We may look forward to a Utopia where the proletariat would rather attend a lecture on the tensor calculus than see a comedy by Charlie Chaplin, but we must admit that that time is not yet. A more pertinent comparison would be between the salaries of scientific men and of other public servants, since the value of the work in these cases is not directly assessed by the public.

The implicit claim in the passage we have quoted, that scientific men should be rewarded with gigantic salaries, is probably not intended by Dr. Little, although the confused feeling which gives rise to it is often apparent in discussions on this subject. The money value of work done is, with nearly every kind of work, extremely difficult to assess. Indeed, the problem is probably best defined in the case of the custard-pie expert, since, if a million people (including men of science) are willing to pay a shilling for his performance, it seems that the monetary value of that performance is one million shillings. But who could possibly have assessed the monetary value of Gilbert's experiments in magnetism, or of Euler's researches on elliptic integrals? And what is the *monetary* value of the theory of relativity which, so far, has had no direct influence whatever on the life of the community? But although we think the scientific man is wrong to envy the income of the successful cinema actor, it is true that science has now sufficiently proved its value to enable the scientific man justly to insist on rewards that shall enable him to keep in good health, prosecute his work in proper conditions, and encourage him to produce and rear children. It is established that he and his offspring are a very desirable social asset; and the real injustice and stupidity of those in power are shown in the fact that even these minimum demands are not properly met.

Dr. Little also complains that scientific men are not admitted to positions of power in the community. In spite of the fact that some of them, particularly during the War, have shown themselves possessed of great administrative abilities, scientific men are not invited to co-operate in the task of government. Yet, seeing how much the modern community is dependent upon their labours, it would seem only natural that they should be given a voice in the direction of affairs. But here again we are met by a demand that requires careful consideration. For good or ill, democracy is the prevalent form of government, and, as Dr. Little says:

"An electorate, which regards itself as free, listens to the broadcast noise of manufactured demonstrations and is blind to the obvious mechanics of synthetic bedlam. The result is too often government by gullibility, propaganda, catchwords, and slogans, instead of government by law based on facts, principles, intelligence, and good will."

These are the conditions which result in the appointment of our leaders, and we may take it that the fittest survive. It is not likely that the men who can swim successfully through this welter will have much knowledge of, or reverence for, the scientific attitude of mind. It is too much to expect that they will demonstrate to the whole world their own incompetence by handing over their business to larger and better-trained intelligences. Once more, what is required is a higher cultural level on the part of the public, a general recognition of the value of the scientific mind in all departments of public life. But here we are hampered by the fact that we have no clear evidence that the majority of scientific men would be of any particular use in the conduct of affairs. It is not wise to make claims that cannot be substantiated, and the views of scientific men, taken as a whole, on political questions seem indistinguishable from the views of an equal number of ordinary citizens. With the majority of scientific men their habit of cautious weighing of evidence, their ingenuity in reducing a problem to its essentials, their lack of prejudice in coming to results, do not noticeably extend to their political opinions. They read newspapers as uncritically as does any other kind of educated man, and far more uncritically than the most insignificant Fleet Street journalist. There is no evidence that the views of the Royal Society on international politics are worthy of any special consideration

While, however, it is true that scientific men, as a whole, rank with the rest of the community in these questions, it may be that there are branches of science in existence which could make valuable contributions to the actual problems of government. This is obviously true of problems which involve technical processes. A general scheme of electrification, for example, should obviously be committed to men of science. Questions concerned with national defence, also, should be, and largely are, in the hands of scientific men. But Dr. Little thinks that men of science could make still more fundamental contributions. He refers us to psychology, and apparently thinks that its findings could already be profitably applied to the general problems of government. This may be true, although it seems likely that the science of psychology should be further developed before any body of legislators should be encouraged to attempt striking improvements by its aid. Undoubtedly science can already furnish much besides "practical applications," but chiefly, we suggest, in giving problems a new orientation and by suggesting new methods of attacking them.

There is another aspect of the general question, an aspect that Dr. Little has not touched upon. Granted that some scientific men possess great administrative ability and that they could play a very effective part in solving problems now left to the politicians, do we want to use our scientific men as administrators? In the United States they are already employed in that way to a greater extent than is customary in Europe; but whatever the benefit to the American community, it is not clear that science in the United States has benefited by it.

Mr. Bertrand Russell has recently given it as his opinion that, in the United States, Einstein would probably have been made the administrator of a large university and, as a consequence, would never have had the leisure necessary to develop his generalised theory of relativity. Would that have been a gain? Was it a gain that Newton should have become an industrious and conscientious Master of the Mint, seeing that he produced no more original work in science for the rest of his life? Newton's work in science certainly saved the labours of two or three generations of scientific men. It is difficult to say when the theory of relativity would have been hit upon if Einstein had devoted his time to other things.

It is not at all clear that a scientific man, as soon as he has proved himself to be of great value to science, should be immediately called upon to do something else, even though the something else should be of more immediate practical utility. Dr. Little informs us that American men of science are not in Congress. Well, they are presumably in their laboratories, which may ultimately be a better thing for the world. Nevertheless, it is desirable that so valuable a group should have a means of making the weight of its opinions effective in government

The true issue is that the scientific contribution should be worthily employed. It should no longer be left to random and sometimes base exploitation. This means that scientific men must come into the arena, and take a greater part than they have yet taken in impressing their ideals, as well as their ideas, on the public. It would not be a bad thing if scientific men developed a "class-consciousness." If scientific ideals are to gain any hold on the community it must be by vigorous propaganda, not by annual laments at the paucity of government grants. There should be lecturing campaigns and periodicals devoted solely to this end. As it is, the writers quoted by Dr. Little are able to say, with some show of justice, that science touches only the fringe of life, that it has no bearing on the centre of life at all. In a democracy one must appeal to the people. Science has a spirit as well as a body, and it is its spirit, even more than its body, which is the potential saviour of mankind.

The Study of Crystals.

(1) *X-rays and Crystal Structure.* By Sir W. H. Bragg and Prof. W. L. Bragg. Fourth edition, revised and enlarged. Pp. xi + 322 + 8 plates. (London: G. Bell and Sons, Ltd., 1924.) 21*s.* net.

(2) *The Structure of Crystals* By Ralph W. G. Wyckoff. (American Chemical Society Monograph Series.) Pp. 462. (New York. The Chemical Catalog Co., Inc., 1924.) 6 dollars.

(3) *Chemische Kristallographie der Flüssigkeiten: Kurze Anleitung zur Synthese und Untersuchung polymorpher und kristallin-flüssiger Substanzen.* Von Prof. Dr. D. Vorländer. Pp. 90 + 30 Tafeln. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924.) 12 marks.

IT is only about twelve years ago since the study of the crystalline state was the most neglected of all the branches of physical chemistry, so much so that a student who was full of learning about ions and about osmotic pressure would probably be unable to define a centre of symmetry or to describe the meaning of hemihedrism, unless he happened incidentally to have been also a student of mineralogy. The marvellous changes which have taken place in recent years have been due almost exclusively to the new methods of studying crystals by means of X-rays, which were discovered by Laue in 1912, and developed without delay by the Braggs. Some fifty-seven papers on the subject were already published in the year 1913, and it was only the diversion of scientific energy to other ends during the War period that kept the output for several years below thirty papers per annum. Since then, as Dr. Wyckoff's bibliography shows, the output has increased to such an extent that on the average two new papers on the subject are now being issued every week.

(1) In the midst of all this activity it is only fitting that a fourth revised and enlarged edition of the book on "X-rays and Crystal Structure," first issued in January 1915, should appear. It is remarkable that, in spite of the great developments that have taken place, this book still retains the charming simplicity of style which enables Sir William Bragg in his lectures to persuade even the simple and the unlearned that learning is both possible and pleasant, even when the subject to be learnt is the science of crystallography. The contents of the book are, however, changed almost beyond recognition, not merely by the inclusion of new matter, but also by the introduction of new types of investigation. Foremost amongst these is the application of X-rays to the study of the structure of organic crystals, where the method only indicates directly the spacing and orientation of the *molecules*, leaving the positions of the *atoms* to be deduced from a blending of stereochemistry with crystallography. In this difficult field caution is obviously needed; but not that type of caution which leads to pessimism, or to a refusal to undertake experimental investigations on the ground that the methods available are wholly inadequate to the task. It is, however, in strict agreement with the facts of chemistry that Bragg regards the diamond as the prototype of all saturated carbon compounds of the "aliphatic" series, and "graphite" as a prototype of the bewildering "aromatic" series, where a latent unsaturation lies concealed beneath a superficial appearance of saturation, like a bankrupt hiding his financial necessities from all but his most intimate friends.

Having thus secured, by the X-ray analysis of diamond and of graphite, a direct foothold in carbon-chemistry, Sir William Bragg and his colleagues have attacked a series of problems of increasing difficulty; and if the results of their investigations have not the same adamantine certainty as in the case of the elements and their simplest compounds, they have been in the highest degree useful to chemists, stimulating them into activity of thought and investigation by means of new conceptions of "chemistry in space," and by the presentation of new problems. It is indeed refreshing to see elementary sulphur treated with the organic compounds and to realise that it has after all most of the characteristics of such compounds, and to see the familiar tetrahedral model of the carbon atom used, with a sound basis of experimental fact, to explain the arrangement of the silicon atoms in quartz. Chemists would be ungrateful if they failed to welcome such intrusions from the most helpful and sympathetic amongst their physical colleagues.

(2) Dr. Wyckoff's book, although addressed to chemists, as one of a series of monographs prepared for their edification at the request of the American Chemical Society, is much inferior in its power of appeal, since no attempt is made to present the story in an easy or simplified form. Even on the first page the reader is presented with a definition of a screw axis of symmetry, of which the familiar rotational axis is treated as a special case, in direct opposition to the humane method of teaching which consists in leading up from the known to the unknown; and already on the fifth page he finds himself entering a thick forest of point groups, beginning with "Point group 1C(C_1) [Hemihedral class]." No apology is therefore needed for the statement that the book would be hard reading for a chemist who had already studied crystallography, or for the advice that a reader who is ignorant of crystallography would do well to buy an introductory text-book on the subject, and master it before tackling

Dr. Wyckoff's monograph. The book is, in fact, suitable as a guide to a research worker taking up the study of the subject, and it will be welcomed by the more mature workers in this field on account of the complete bibliography which it contains; but it is quite unsuitable for the general reader, who would find it more profitable to allow the Braggs to explain to him the methods and results of the new processes of analysis.

This does not mean that the book is of no value to the chemist; but rather that he must chew hard in order to extract small scraps of nourishment from this very strong meat. Thus it is interesting to be told that in the alums "three of the oxygen atoms in the sulphate group are geometrically alike but different from the fourth, and that the water molecules fall into two groups of six each," since this agrees with the distribution that one would picture in a double sulphate of a univalent and a tervalent metal. Still more fascinating is the statement that, in the ammonia alums, the only arrangement of the four hydrogen atoms which is consistent with the crystal symmetry is a linear one with a nitrogen atom in the centre of two pairs of hydrogens. Since this is chemically improbable (not to say impossible), it is suggested that "the ammonium group functions crystallographically as well as chemically as a single entity, and that its hydrogen atoms need not therefore occupy positions which conform to the demands of the crystal symmetry. This hypothesis probably cannot be directly tested either optically or with X-rays because it is unlikely that the hydrogen nuclei are centres of electron motions" (p. 363) It is, however, noteworthy that, in Morgan and Bragg's analysis of the crystal structure of basic beryllium acetate, the univalent methyl groups are placed with their carbon-to-carbon bonds in the line of the axes of *two-fold* symmetry, in spite of the fact that the three hydrogens of the methyl group demand instead an axis of *three-fold* symmetry. It looks, therefore, as if, in the theory of crystal structure, hydrogen again occupies an unique position, and requires to be treated differently from all other elements.

Dr. Wyckoff devotes a chapter to "Incomplete Crystalline and Non-crystalline Diffraction Phenomena," in the course of which he refers to the so-called "liquid crystals." It is now clear that these queer anisotropic liquids cannot be assigned to any known or theoretically possible class of crystals; but since they also have been subjected to analysis by X-rays, it will not be entirely out of place to include in this review a brief notice of a monograph of ninety pages by Prof. Vörlander (3), whose name has been associated, during a period of nearly twenty years, with work on the chemical aspects of this fascinating subject. So long ago as 1906–7, Vörlander showed the importance of a linear structure of the molecule for the development of anisotropy in the liquid state, and proved that in derivatives of benzene the substituents must be in the *para* position in order to produce this effect, which disappears in the case of the isomeric *ortho* and *meta* compounds.

The present monograph, under the somewhat misleading title of "Chemical Crystallography of Liquids," proceeds along similar lines, the fundamental proposition that anisotropy in liquids implies a linear molecular structure being applied as a test of the molecular form of a large variety of compounds. It is shown, for example, that where a normal propyl and a normal butyl derivative of *p*-azoxycinnamic acid have a range of stability in the anisotropic state of 112° and 103° respectively, the *iso*-propyl and *iso*-amyl derivatives, with branched chains, have a range of only 35° and 42° respectively. It is, therefore, definite evidence of the zigzagging of a hydrocarbon chain that a single CH_2 group between two aromatic nuclei prevents the development of anisotropy in the liquid, whereas this phenomenon is developed strongly when there are two CH_2 groups, and appears again in a less striking degree when the number of CH_2 groups is increased to four. Since the author claims to have laid down rules which have led to the preparation of 2000 compounds of this type, he is obviously in a very good position to discuss the origin of the phenomenon. It is also desirable to direct attention to the exceptional skill which the author has shown in securing photographic reproductions (unfortunately only in black and white) of his observations. This skill was already manifest in his earliest papers in the *Zeitschrift für physikalische Chemie*, and he has certainly not lost it in the intervening years, since the monograph now under review includes a series of sixty-one beautiful photomicrographs, which would by themselves fully justify the purchase of the book.

T. M. Lowry.

Sexuality and Hormones.

Sexualité et hormones: les caractères sexuels considérés comme phénomènes de développement et dans leurs rapports avec l'hormone sexuelle. Par Prof. Ch. Champy. Pp 376+7 planches. (Paris: Gaston Doin, 1924.) 30 francs.

PROF. CHAMPY is one of the most versatile and rapid of biological workers. Tissue-culture; amphibian metamorphosis; the mode of action of hormones; the theory of sex; growth;—he has touched on and illuminated all these fields within the last few years. In the present volume he presents a thesis, based on various aspects of this work, which

is of considerable importance. Perhaps the best way to show its importance will be to set down a series of the established facts on which it is based, letting them tell their own story, and then criticising some of the more theoretical part of Champy's interpretation.

As everybody knows, the majority of secondary sexual epigamic characters arise in development by the more rapid growth, at one period or other, of some rudiment common to both sexes This may take place once and for all, or regress and recur seasonally Some years ago Pézard very thoroughly analysed the influence of the testis upon the growth of the fowl's comb, and found that whereas the comb of the capon grew proportionately to the rest of the body, that of the bird possessing a testis grew disproportionately. The former type of growth he christened *isogonic*, the latter *heterogonic*. After a certain period of heterogonic growth, however, equilibrium is attained, and growth becomes again isogonic, but at a new level

In various lower forms of life, however, heterogonic growth continues permanently This is true, for example, for the claws of male fiddler-crabs. Thus, the large male fiddler has, not only absolutely, but also relatively, larger claws than the small one Here, by the way, the morphologist meets with a stumbling-block The male fiddler-crab has *no* fixed form. Its form, in respect of the proportions of its parts, is only a function of its absolute size

Next point: in many insects, in spite of the fact that no moulting or growth occurs after the imago stage is reached, a similar phenomenon is found; the absolutely larger individuals possess relatively larger sexual characters This is true of the ordinary male stag-beetle, and to a remarkable degree of the Hercules and Goliath beetles Champy rightly concludes, like his predecessors, that the definitive visible effect is due to a continuous process of growth—the accumulation at a heterogonic rate of some substance responsible for the production of the particular organ.

Secondary sexual characters, however, are not the only ones to show heterogonic growth. That is also found, for example, in the limbs of frog-tadpoles; and here, further, the rate of growth is quantitatively related to the amount of thyroid hormone present.

Then, as Lameere in France, and Geoffrey Smith in England, pointed out, the phenomenon extends beyond the limits of the single species Within a group such as the stag-beetles, the larger *species* on the whole have relatively larger sexual characters than the smaller.

Here we clearly have a mechanistic explanation of much of "orthogenetic" evolution. Granted this particular mode of development for certain organs in a given group, then these organs will tend to become relatively larger in larger species, unless counter-measures are taken. If the course of phylogenetic evolution of the group happens to have run from small to large size, then the organs in question will show an apparently determinate evolution, although the only determinism will, as a matter of fact, be that involved in the single type of developmental machinery possessed by the whole group. This appears actually to have occurred among mammals with the horns of the Titanotheres and the antlers of the Cervidæ.

Champy also points out that the details of the heterogonic organ are usually specific, varying from species to species; while, on the other hand, the type of growth is common to all members of the group. This would imply a fundamental growth mechanism, with different individual genes embroidering the resultant organ in various ways in various species. There is also the fact that highly adaptive sexual characters, such as certain copulatory organs, ovipositors, etc, do not show heterogony, but are of fixed relative size This we take as an adaptation, in that size-variation would interfere with nicely specialised function

Finally, the author gives the results of some interesting experiments he has made on the growth of seasonally recurrent secondary sex-characters in Amphibia in relation to their nutritive condition. In brief, he introduces us to the following conception for organs like the glands in the male frog's thumb-pad, or the crest of male newts, there are two limiting factors involved—first, the testis-hormone; secondly, the nutritive condition of the animal. The hormone is necessary for the appearance of the organ, but is efficacious even in very small quantities (*e.g* when produced by small regenerated nodules of testes after attempted castration); anything above a small threshold-value exerts a constant influence. The actual effect produced when excess gonad-hormone is present, however, depends on the excess of nutriment present. Very fat frogs with a bare minimum of testes retain thumb-glands of maximal size, while unoperated but emaciated frogs show great reduction of the glands, which are sometimes not to be distinguished from those of full castrates. In practice, therefore, nutritive condition is the effective limiting factor. These considerations, as Champy justly points out, vitiate many of the castration experiments that have been carried out on amphibians.

As regards general considerations, it remains to mention two points not touched on by Champy. One concerns the quantitative side of heterogonic growth. Champy gives here some suggestive figures, but far too few to establish any assured law of growth. The reviewer has recently taken the matter up in fiddler-

crabs, and finds that, if y = weight of the male's large chela, w = total weight of the crab, then $\log y = \log b + k \log (w-y)$, where $k > 1$.[1] This gives us a first firm step into the details of the process

In the second place, there is the whole problem of what we may call *minus-heterogony*. In the cases which have so far been considered, we have *plus-heterogony*—organs grow faster than the body as a whole But if the growth-rate of an organ were slower than that of the rest of the body, it would become relatively smaller as the animal becomes bigger. Very little attention has been paid to this problem There seems, however, little doubt that the "degeneration" of the male elements in the female accessory reproductive system, and vice versa, will be found to be not a phenomenon of true degeneration, but of depressed relative growth-rate It is usually not realised what an enormous difference in end-result is accomplished by a small but constant difference in relative growth-rate. In the fiddler-crabs above cited, the male chela grows about 1½ times as fast as the rest of the body, and increases from 2 to 65 per cent of the weight of the rest of the body during growth to a total weight of only 3½ grams With a growth-rate of two-thirds the rest of the body, an organ would be negligibly small in a mammal weighing 100 grams at birth. The same is probably true of very many vestigial organs, which would account for their rudiments usually being relatively much larger in the embryo than in the adult. Putting it in another way, we may say that the biologically simplest way of altering the relative size of an organ in the adult seems to be by altering its relative growth-rate during development. The study of quantitative relations during development will thus develop into one of the keystones of biology, throwing light both upon the mode of action of genetic factors and upon the appearance of adult characters It will stand in the same relation to morphology as does physical chemistry to ordinary inorganic chemistry.

We may conclude by a few detailed criticisms. Prof. Champy has given us that irritating thing, a book without an index. That is a vice more prevalent in France than in Britain; but custom does not make it any more excusable. He has unaccountably failed to make any reference to Geoffrey Smith, whose work, published so long ago as 1905, was one of the earliest and most penetrating contributions to the subject of heterogonic growth. He states that he has been unable to find any case of heterogony in a female secondary sex-character—a statement later qualified in the postscript, where he mentions the elytra of the females of two genera of beetles. The type of growth is, however, common in crabs, where it appears to be universal for the abdomen and abdominal appendages of the females. As regards another point, there seems no reason for abandoning Pézard's term *heterogonic* and substituting *disharmonic* for this type of growth.

The drawings are often rather sketchy, and some of the series of insects not quite so convincing as one would wish, while the section on the respective rôles of spermatogenic and interstitial tissues in producing the testicular hormone has no real connexion with the rest of the book

However, there is no doubt that the book is extremely stimulating, and presents a large number of facts, many of them new, in a way which should excite interest and promote research in an almost untouched and very important field of biology We have no hesitation in recommending it to the notice of systematists, morphologists, and experimenters alike

J. S. H.

[1] See NATURE, December 20, p. 895.

The Biology of Plants.

The Biology of Flowering Plants By Dr Macgregor Skene (Biological Handbooks Series.) Pp xi + 523 + 8 plates (London: Sidgwick and Jackson, Ltd., 1924.) 16s net

THE title of Dr Skene's book can be interpreted in various ways and, at its widest, would embrace the entire field of botany, this could only be dealt with in the most superficial manner in the compass of a single book Here, however, Dr. Skene has restricted himself to a consideration of the relation of the individual to its environment in the sense usually connoted by the term autecology, more particularly as regards those aspects which might be included under applied physiology In his treatment the author has succeeded in incorporating much of the physiological work of recent years, and in a very readable manner points to its bearing on the life of the plant in Nature. The exposition is in general clear, and if the author has at times failed to steer a middle course between the Scylla of technical expression and the Charybdis of obscurity, he has at least avoided the shoals of ambiguity and misconception.

An elementary account of the soil and its function in relation to the supply of water and mineral salts is the occasion of reference to recent work on the hydrogen-ion concentration of the soil solution, the work of Weaver, Cannon, and others on root systems, and a much too brief reference to the soil organisms. The chapter on assimilation and transpiration rightly occupies a considerable section of the book. The present position of our knowledge respecting the function and regulatory action of the stomata is clearly

summarised. There can, indeed, be little doubt that the *primary* function of the stomata is not the regulation of the passage of water vapour but of the gaseous exchanges involved in respiration and assimilation. This is well shown by the fact that stomatal movement is chiefly determined by changes in illumination and by the observations of Lloyd that the maximum aperture of the stomata is maintained between 8 A.M. and 1 P.M., whereas the maximum period of transpiration begins two hours later and ends an hour earlier. The high osmotic pressure attained by the guard cells in bright light probably ensures their maximum efficiency at a time when the demand for carbon dioxide is greatest, but also involves the well-known fact that the stomata may remain open whilst the rate of transpiration is excessive and the leaf actually wilts. As automatic checks to transpiration the stomata may then fail just when most needed

The account of assimilation deals with the conditions governing the process, particularly with the results of Blackman, Willstatter and Stoll, Lundegardh, Briggs, and so on. In this connexion one may perhaps demur to the acceptance of Lundegardh's interpretation that shade leaves are less efficient in respect of diffusion than sun leaves, since the results he obtained are more probably due to the more efficient use of radiant energy by the shade leaf than the sun leaf. Comparisons on the basis of leaf area are manifestly misleading, but those in which equal weights of fresh leaf have been compared show that shade leaves are often much more efficient than sun leaves in low intensities of light and slightly so in bright light. These results, even allowing for the difference in respiration rates, are scarcely compatible with Lundegardh's assumption of slower diffusion in the shade leaf. The mechanism is possibly connected with the higher proportion of green pigments which the chlorophyll of shade leaves contains and in many cases to a higher chlorophyll content, but other factors are probably involved of which we are at present ignorant.

The succeeding chapter treats of the special modes of nutrition as exemplified in saprophytism, parasitism, and the various mycorhizal relations. This is followed by an account of the mechanical requirements of plants as shown by their gross anatomical features and morphological modifications Reproduction and methods of dispersal, which form the subject of the next chapter, and development, which is the final section, scarcely receive adequate treatment. The work concludes with a bibliography of more than six hundred titles of papers cited in the text, and two indices which might more conveniently have been combined.

In a work covering so large a field the treatment is naturally uneven. The subject of galls, for example, is dismissed in half a page, whilst seed dispersal occupies barely ten pages of type, and the author is clearly more at home in the physiological than in the more morphological aspects of his subject. The pages are nevertheless full of interest, and it is certainly a book which students will find most helpful as indicating the trend of certain aspects of modern botanical thought.

E. J. SALISBURY.

Our Bookshelf.

The Romance of Plant Hunting. By Capt. F. Kingdon Ward Pp. xi + 275 + 8 plates (London: E. Arnold and Co., 1924.) 12*s.* 6*d.* net.

CAPTAIN KINGDON WARD has written a book of considerable interest both to the lover of plants and also to the geographer and traveller, since he is able to show not only the interest which attaches to plant collecting, but also the many difficulties which the good plant collector must overcome in order to be successful. Botanists and keen gardeners are likely to be more interested in his book than the public at large since he naturally has to refer to so many plants by their Latin names. The general reader, however, is amply compensated by the fine set of pictures both of general scenes and particular plants with which the book is illustrated.

The volume is the outcome of three separate journeys in China before the War and of three undertaken during 1919, 1921–22, though the last is the one most drawn upon in the narrative. There is a good map at the end of the volume which enables the reader to follow the author in his wanderings. Those who have received seeds collected by Capt. Kingdon Ward realise that he is a really good collector as his seeds have germinated with remarkable success and he also has the keen eye for plants of interest. Whether they may happen to be "first class" in the idea of the nurseryman or not, they are certainly of value to the botanist.

Capt. Kingdon Ward tries to pretend he is not a botanist and in some ways perhaps he is not, but his early training at Cambridge, with which the writer had something to do, and his inherited tastes from his distinguished father, have given him a love for flowers and a keen interest in the remarkable play on form and structure to be met with in the vegetable kingdom. With the author's second chapter we are not wholly in accord and one would have wished that some things in it had been omitted, but this does not detract from the really interesting and, as he rightly terms it, the romantic side of plant collecting.

The chapters when the author is on the march must be read in full to be appreciated, and no review can cover the ground sufficiently to make the reading of the book unnecessary. There is much to be found in the pages beyond the mere hunting for special plants, and much of value is recorded as to the geology and geography of the regions visited. Capt. Kingdon Ward is a true naturalist and very little escapes his keen eye. The book is enlivened by interesting particulars about the various peoples with whom he came in contact;

nor is the humorous side of his travelling experiences forgotten, though no doubt at the time the humour was not always evident. We feel sure that when the good plants introduced by Capt. Kingdon Ward become better known, his name will rank high in the list of distinguished plant collectors to whom British horticulture owes so much.

Light and Sound: a Text-book for Colleges and Technical Schools. By Prof. William S. Franklin and Prof. Barry MacNutt. Pp. vi+310. (Lancaster, Pa.: Franklin and Charles; London: Constable and Co., Ltd., 1924.) 5*s.* net

Electricity and Magnetism: a Text-book for Colleges and Technical Schools By Prof. William S. Franklin and Prof. Barry MacNutt. Pp xvi+294. (Lancaster, Pa.: Franklin and Charles; London: Constable and Co., Ltd., 1924.) 5*s* net

THE two volumes under notice are revised versions of previous editions, and are said to be suitable "for colleges and technical schools." As regards scope it is somewhat difficult to place them, for according to English standards it is curiously uneven. There are many excursions into topics of a more advanced character than is usual in books of this size (and price), but the treatment is mainly non-mathematical, and has a strong practical or engineering flavour Nevertheless, it is usually so lucid as to repay perusal by the average "pure science" student. The sections dealing with lens imperfections and alternating current are particularly good. On the other hand, the methods given for simple lens calculations might be expected to drive even the engineering student, for whose benefit they have presumably been "simplified," to graphical methods for safety. On the whole, however, if the general viewpoint is acceptable, there will be little to criticise in matters of detail, which are usually accurate and up-to-date. An exception, albeit a trifling one, is the statement that "the most accurate wave-length measurements are made by means of the Michelson interferometer." To the English reader the frequent occurrence of such units as "abohms," "stathenries," and the like will at first be a little disquieting, but he may eventually find in their obvious convenience some compensation for their exotic appearance.

Le Volvox. Par Charles Janet. Troisième mémoire: *Ontogénèse de la blastéa volvocéenne.* Première partie. Pp. 179+planches 5-21. (Macon: Protat frères, 1923.) n.p.

IN this third memoir M. Janet approaches the problem of the ontogenesis of the Volvox blastea (cœnobium). He confines himself to the methods of cell bipartition, but in later works he proposes to discuss variations in the process and special cases. The memoir is an able attack on an exceedingly intricate and difficult problem and contains a wealth of minute detail. The author starts by pointing out the primitiveness of the Volvox cell and how, in his opinion, these blasteas are in large measure representative of the primitive animal cell groups. He then goes on to describe the apparatus by means of which he separates out the minute organisms, and having pointed out the fundamental units of the cell he considers the homologies between the blasteas of plants and animals. Thereafter he examines the divisions of the cells of *Janetosphæra aurea* (Ehrbg.) Shaw, in greater detail. It can be well understood that in such an involved study a comprehensive scheme of terms is required; these the author has supplied as well as formulæ for expressing symbolically the type of generation and the mode of reproduction of the organism under study Assisted by 21 excellent plates containing many figures and diagrams, he traces the various divisions and shows that after bipartitions resulting in 1024 cells, the cells of *J. aurea*, having reached their minimum limits and used up all available reserves, cease to divide and enter into a new phase—the flagellate stage. Throughout, the work is one where questions regarding evolution in the plant world are always kept to the front, for the author's knowledge of plant and animal life permits him to make useful comparisons

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend (Griffin's Scientific Text-Books.) Vol. 2: *The Alkali-Metals and their Congeners.* By Dr. A. Jamieson Walker Pp xxvi+379. 20*s.* net. Vol. 7, Part 1: *Oxygen.* By Dr. J. Newton Friend and Dr. Douglas F. Twiss Pp. xxvi +370. 18*s.* net. (London: C Griffin and Co., Ltd., 1924.)

THE two new sections of Dr. Friend's "Inorganic Chemistry" deal with (1) hydrogen, the alkali metals, the ammonium-compounds, and the coinage-group of metals, and (2) oxygen, water, and hydrogen peroxide. The style of the book is now so well established, and so well known, that it is difficult to comment usefully on the individual sections as they appear. The parts now issued appear to be very complete in the information supplied; and the expansion of the section on oxygen to a volume of 350 pages has made it possible to include a much larger number of analytical data than it is now fashionable to quote in a text-book, as well as to deal in unusual fulness with modern work on combustion By contrast, the volume on the metals of Group I. appears to be somewhat abbreviated, since the three metals of the coinage-group are disposed of in little more than 100 pages Illustrations are also used less freely, being limited to a few solubility diagrams, etc., and two line-drawings, thirteen in all. The section on oxygen, on the other hand, is illustrated with some fifty diagrams, and a full-page plate showing the photographs by Burgess and Wheeler of flames near the lower limit of inflammation of methane in air. The homologues of oxygen (sulphur, selenium, and tellurium) are postponed to a later section of Vol VII., whilst the remaining elements of Group VI. will form a separate Part III.

Venereal Disease: its Prevention, Symptoms and Treatment. By Hugh Wansey Bayly. Second edition. Pp. xvii+176. (London: J. and A. Churchill, 1924.) 7*s.* 6*d.* net.

VENEREAL disease, like all infectious maladies, is to be considered from two aspects, those of prevention and treatment. The importance of the former certainly has full recognition in Dr. Wansey Bayly's book, the preface of which is devoted mainly to a defence of the policy of the Society for the Prevention of Venereal Disease. In the first section of the book the author

puts forward a scheme whereby he considers that syphilis could be almost entirely eliminated in a generation. Briefly, it consists in compulsory notification to a special Medical Officer of Health, who visits the victim, ascertains from whom the disease was contracted, and traces that individual. Infected persons are given the choice between treatment at a hospital and attendance on a physician of their own selection. Heavy penalties are attached to the doctor who fails to notify, and to the individual who conveys disease to another before being certified free from infection Such a scheme might, however, defeat its own ends by driving the patient to abstain from treatment altogether or to obtain it secretly and illicitly at the hands of quacks

The sections on symptoms and treatment, which comprise the greater part of the book, are clear, concise and fully up-to-date For the student and general practitioner who have not the time to devote to large text-books, there could not be a better guide.

Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company. Vol. 6, 1922 Pp 238+vii. (Rochester, N Y · Eastman Kodak Co , 1923) n p

Owing to the increasing number of communications from the Eastman Kodak Laboratory, it has been decided to issue a volume of abridgments every year. The present volume deals with the papers that were published in 1922, many of which were referred to in our columns when they first appeared These abridgments are not mere statements of the subjects dealt with, but are the papers themselves, shortened somewhat by the omission of some of the details that are not necessary to the understanding of the work done and its results Those specially interested will naturally consult the original publication for fuller particulars and especially for more complete data. The 30 papers included in the volume are classified under the headings of physical and photographic optics , inorganic, organic, physical, and colloid chemistry ; photographic theory, and practical photography The character of the work done is now so well known that it is not necessary to enlarge upon it, except to say that several new instruments are described that have been constructed to enable investigations to be carried further than has hitherto been possible

The Amphibia of the Indo-Australian Archipelago By Prof. Dr P N. van Kampen. Pp xii+304 (Leyden: E. J Brill, Ltd . 1923.) n.p

The Malay Archipelago, consisting as it does of a large number of islands separated in many cases from one another by very deep sea, has yielded many very interesting problems in the science of the geographical distribution of animals Nothing perhaps could afford more useful information in the attempt to solve these problems than a thorough knowledge of that essentially terrestrial and freshwater group, the Amphibia.

Prof. van Kampen, of the University of Leyden, has therefore rendered great service by preparing for the use of students a critical study of the 254 species that are known to occur in the Dutch archipelago together with New Guinea, the Bismarck archipelago and the Solomon Islands. The descriptions of the species are mainly technical in character, but so far as possible an account of the tadpoles and some notes on habit are included. There is a useful synopsis of characters at the head of each family and genus, and there are a few excellent illustrations.

Ophthalmo-Optical Manual. By William Swaine. Pp. v+152 (London . The Hatton Press, Ltd., n.d.) 5*s* net

We welcome the appearance of this little volume, because there is a real need for a practical handbook on the main essentials of sight-testing. In this book the subject is treated in a scientific manner seldom adopted in text-books of this nature. The more recent developments of sight-testing are considered , of particular interest are the corrections required to flat trial-case refraction values when toric and similar lenses are to be used. This was first pointed out by the author and is as yet scarcely appreciated by the average optician The unit planes of such lenses are in quite different positions (relative to the eye) from those of the standard trial case lens, and consequently the refraction values for such lenses have to be materially altered. In addition, a number of very useful tables have been included, and these, together with an exhaustive index, make it a valuable reference book.

Warley Garden in Spring and Summer. By Ellen Willmott Second edition Pp ii+41 plates (London · Wheldon and Wesley, Ltd., 1924.) 10*s*. 6*d* net.

This series of beautiful pictures of a famous garden would have been of some general interest had they been accompanied by a plan of the Warley Garden and some particulars about the plants that are in cultivation there As it is, they are merely a collection of pictures, some of which are of no great merit Among the best are the Alpine primroses, Plate 5, and the Nankeen lilies, Plate 31, but had the actual names of the plants depicted been given, in these and other cases, the volume would have been of far greater value to those interested in gardens.

It is to be regretted that a garden, which has so much charm and is owned by a lady who is so fitted to describe it, is merely illustrated in this series of pictures and all that is of real value is left unrecorded.

Unscientific Essays. By Prof. Frederic Wood Jones. Pp. 208. (London: E. Arnold and Co., 1924.) 6*s*. net.

A man is largely known to his friends by his hobbies, and clearly our author's hobby is to sit and reflect, occasionally feeling himself stimulated to jot down what he feels or has seen. He has a broad experience of the wild, both on sea and land, almost unexplored coral reefs of Malay and deserts of Australia. He liked the natives with whom he came into contact, and frequently he has blended folk-lore into his themes, this being perhaps the most interesting feature of his book. He tells us the crab's secret, and of course he caught a sea-serpent, his account of which we first saw repeated in the daily press with references to his official position as a professor of anatomy. As such, journalists apparently supposed him to have no lighter moments ; his essays are just the thing for our ease.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Effective Wave-lengths of γ-Rays.

One of the difficulties in explaining the results of experiments on γ-rays is our lack of knowledge of the variation of intensity with wave-length in the spectrum of the γ-rays. This has led to the use of "effective" wave-lengths (two, in general, being needed because scattering and absorption coefficients vary with the wave-lengths in different manners), and values have been used, which, although incorrect, apparently help to explain the experimental results. For example, I have pointed out at two scientific meetings (American Physical Society, December 1922, and the British Association, Toronto, August 1924), that if we assume, as has been done by several physicists, that the effective wave-length of the γ-rays is about 0·02 Å.U., the secondary β-rays produced in light elements by the hard γ-rays of radium-C possess far too much energy to be recoil electrons (for the properties of which see a paper by Compton and Hubbard, *Physical Review*, 4, p. 439, 1924). Experimental evidence indicates that these β-rays are not photoelectrons. If they are recoil electrons, the effective wave-length of the γ-rays must be taken as about 0·008 Å.U. in order that we may account, on the quantum theory of scattering, for their observed energy. This result, which was first obtained by a comparison of the relative penetrating powers of the secondary β-rays and the β-rays of radium-E, has led, among other things, to a consideration of the following questions.

1. What proportion of the atoms of an element emitting one or more types of monochromatic γ-rays contributes, on disintegration, to such γ-rays?

2. Is a knowledge of the wave-lengths and relative intensities of the lines in the spectrum of γ-rays sufficient to enable us to determine effective wave-lengths and, with theoretical aid, to interpret the results of scattering and absorption experiments?

3. Is the energy of the secondary β-rays which have been called recoil electrons greater than that given by the quantum theory of scattering?

4. Are the γ-rays of thorium-D always more penetrating than those of radium-C, no matter what the thickness of the absorbing material used?

I am not prepared to answer questions 3 and 4 and cannot give a complete answer to the other two. The simplest case to examine is radium-D. In the course of his fundamental experiments on the line spectra of γ-rays, Ellis (Proc. Camb. Phil. Soc. 21, p. 121, 1922) has shown that radium-D probably emits "hard" γ-rays of wave-length 0·264 Å.U., part of these rays being absorbed in producing the L and M spectra of radium-D, the "soft" rays, of average wave-length 1·06 Å.U. By a comparison of the total ionisations they produce, I find that the energy of the soft rays = ¼ that of the hard rays, and as the energy of a hard ray = 1·06/0·264 or 4 times that of a soft ray (if such expressions may be used), it follows that out of every three hard rays emitted by the nuclei of radium-D atoms, two are absorbed in the atoms in which they are produced. The internal atomic absorption coefficient of the hard rays, assuming them to produce the soft rays in the way mentioned, is therefore 0·67 as compared with an external coefficient of about 3×10^{-21}. Ellis and Skinner have directed attention to the very high values of these internal absorption coefficients. It may be worth while pointing out, in connexion with experiments on the scattering of X-rays, that such a high internal coefficient of absorption is not observed with β-rays.

The energy of the unabsorbed hard γ-rays has been found by ionisation measurements to be 1/150 that of the β-rays of radium-E in equilibrium with the radium-D. Taking the average energy of such a β-ray to correspond to 467,000 volts, of a hard γ-ray to 46,700 volts, a simple calculation shows that only one in every five radium-D atoms emits a γ-ray on disintegration. Radium-D apparently does not emit "white" γ-rays or rays which give a continuous spectrum and so we have fairly complete knowledge about it, but this is not the case with most of the other elements emitting γ-rays.

In a recent paper, Ellis (Proc. Camb. Phil Soc. 22, p. 369, 1924) publishes a table giving some of the lines in the spectrum of the hard γ-rays of radium-C, extending from 0·0453 Å.U. to 0·00557 Å.U. What appears to be the most intense line has a wave-length 0·00867 Å.U., a value not very far from that given above. Such tables, however, even if we knew the relative intensities of the lines, do not enable us to find effective wave-lengths of γ-rays, unless we are certain that only a negligible proportion of the radiation is white. That a large part of the γ-radiation of thorium-D is white, is indicated by the following evidence, to which Ellis (Roy Soc Proc. A, 101, p. 1, 1922) has directed attention. The lowest wave-length found by him so far in the line spectrum of these rays is about 0·014 Å.U., and yet they should have a lower average wave-length than the γ-rays of radium-C, as they are more penetrating (see question 4 above), hence the probability of white radiation of very small average wave-length. In the case of radium-C there is not sufficient evidence, so far as I am aware of it, to come to a definite conclusion about the presence or otherwise of white radiation. The following results have been arrived at.

1. If the secondary β-rays, produced in light elements by the hard γ-rays of radium-C, are recoil electrons, with energy given by the quantum theory of scattering (see question 1 above), the effective wave-length of the γ-rays must be much smaller than that usually accepted. Without going into details, I may state that one can prove from this result that no theory, as at present developed, can account for the properties of scattered γ-radiation.

2. With certain reasonable assumptions, it has been found that the internal atomic absorption coefficient of the hard γ-rays of radium-D is 0·67 as compared with an external coefficient of about 3×10^{-21}, and that on disintegrating, one out of every five atoms of radium-D emits a γ-ray.

3. The number of atoms of an element emitting one or more types of monochromatic γ-rays may be only a small fraction of the total number disintegrating and a large part of the γ-ray energy emitted may be due to white radiation.

4. A knowledge of the wave-lengths and relative intensities of the lines in the spectrum of the γ-rays is not, in itself, sufficient to enable one to determine effective wave-lengths, which can be used to interpret the results of experiments on γ-rays.

I think it may fairly be said that it is very difficult to explain the results of experiments on γ-rays of very small wave-length. Definite answers to questions 3 and 4 would help very much. There is not space here to give fully my own opinions, which I must reserve for a communication elsewhere.

J. A. Gray.

Queen's University,
Kingston, Ont., December 6.

Specific and Latent Heats of Iron and Steel.

In previous letters to NATURE (April 19 and September 20) I gave the results of some experiments on the rate of contraction of heated iron and steel wires, partly commercial steels, and partly of steels formed by heating nearly pure iron in graphite for periods lasting from one to five hours. It was found that even the five hours' heating in graphite did not complete, or even nearly complete, the conversion of iron into steel. A similar and more recent series of trials has now been carried out in which the graphite was replaced by wood-charcoal, from which it appears that the action of the latter is far more rapid than graphite, so much so, indeed, that a wire heated in charcoal for a single minute gives a cooling curve notably different from that of the pure iron.

Some of the results are shown in the accompanying diagram (Fig. 1), where the curves refer to nearly pure iron (4 parts in 10,000 of carbon) and to the same iron after remaining in wood-charcoal at a cherry-red heat for two and a half, five, ten, and twenty minutes, one hour, three hours, and four hours respectively. The greater part of the variation of form occurs in the first half-hour's heating, and the difference between the three-hour and four-hour curves is comparatively small.

In all cases the cooling curves well above and well below the critical temperature (*i.e.* from melting point down to about 800° C. and from 400° C. down to ordinary temperatures) are identical, but the presence of carbon prolongs the time required for the metal to change from the high to the low temperature state.

While this change is proceeding, latent heat is being evolved, and whether the wire rises in temperature and expands (showing what has been called "recalescence") during this process depends on whether the rate of evolution of heat exceeds, or falls short of, the rate at which heat is being lost by radiation and convection.

It has been shown, by experiments previously described in NATURE, that the coefficient of thermal expansion for iron and steel undergoes no discontinuous change at any temperature to which the metal was subjected. Assuming for the present purpose that the coefficient is constant, it will be seen, since the loss of temperature in cooling is proportional to the excess of temperature above the surrounding space, and since also the time taken to cool through a given number of degrees is proportional to the specific heat, that therefore the area contained between the cooling curves and the axis (*i.e.* extension in terms of time) is proportional to the total quantity of heat yielded in the cooling process.

Thus, from the results exhibited in Fig. 1, it appears that

(1) The greater the carbon content of the metal, the longer is the time required to complete the change from the high to the low temperature state, and the lower is the temperature at which the conversion ends.

(2) The greater the carbon content, the less is the total heat necessary to raise the metal from ordinary temperature to anything above 400° C.

(3) The effective specific heat changes continuously while the change of state is in progress, but the change is more and more rapid as the carbon content diminishes, becoming probably instantaneous, or nearly so, for pure iron.

(4) The terminal specific heats (namely, from above 850° and below 400° C.) are very nearly in the ratio of one to three.

All the phenomena presented in the tempering of steel are connected with the change of state, and it seems likely that useful information might be derived from records of the contraction which occurs in cooling if made under standard conditions.

It is worth notice that in all the experiments I have made, a small permanent increase of length has occurred at each successive heating when the iron was nearly pure, but that when the carbon content reaches a certain limit this change vanishes, and is replaced by a small permanent contraction when that limit is exceeded.

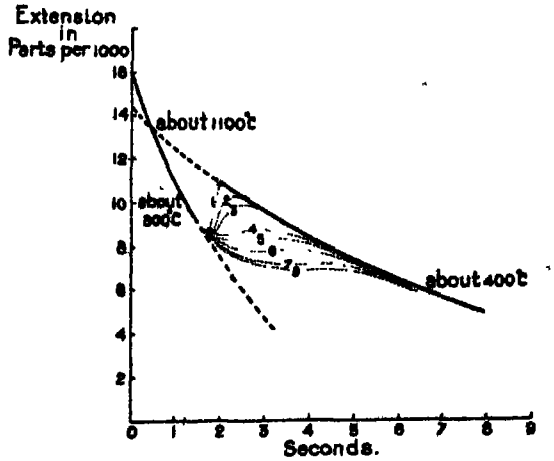


FIG. 1.—Curves showing the contraction of iron and steel wires after heating (by an electric current) in an atmosphere of nitrogen. The iron was produced by the reaction between iron sesquioxide and aluminium. Analysis showed that the metal contained about 4 parts of carbon in 10,000. A small ingot of this iron was drawn into wire of 0·02 in. diameter, and lengths of this wire were heated to a cherry red in wood-charcoal for times specified below. The ordinates of the curves give the extension of the wires at the times indicated by the abscissæ. Approximate temperatures are indicated.

Curve	Time of heating in charcoal
1	0 minutes
2	2½ ,,
3	5 ,,
4	10 ,,
5	20 ,,
6	60 ,,
7	180 ,,
8	240 ,,

A. MALLOCK.

9 Baring Crescent, Exeter,
December 6.

An Endotrophic Fungus in the Coniferæ.

In a communication to NATURE of December 13, Prof. F. J. Lewis directs attention to the discovery of intercellular mycelium in the shoot tissues of *Picea canadensis* and other conifers, and also in roots and shoots of *Ledum palustre* and *Vaccinium Vitis-idæi*. Referring to the two last-named species, Prof. Lewis writes: "an examination of the root and stem of *Ledum palustre* and *Vaccinium Vitis-idæa* from this district has been made, and an endotropic [?endotrophic] fungus has been found similar to that described by Rayner (*Annals of Botany*, 1915) in European material."

The fact that endotrophic mycorrhiza occurs in the *roots* of these plants has long been known and calls for no comment. A full account of the mycorrhiza of *V. corymbosum* was given by Coville in 1911 for American material.

In the paper cited by Prof. Lewis, the present writer described the wide distribution of mycelium throughout the shoot tissues of Calluna and recorded the fact of ovarial infection—implying a like distribution of the fungus—in *Ledum palustre* and *Vaccinium*

Vitis-idæi. A paper now in the press, recording the regular and extensive digestion of mycelium in the mycorrhiza cells of Calluna, contributes additional details respecting the distribution of mycelium in the shoot of Ling and supplies final experimental proof of the identity of the fungus (in the vegetative shoots as in the fruits) with that found in the (root) mycorrhiza.

In view of the conclusions published by Stahl in 1900, the genus Vaccinium is of special interest. In a paper shortly to be published, an account will be given of experimental researches on Vaccinium spp extending over a number of years and evidence supplied that the relation between fungus and vascular plant is even more intimate in this genus than in Calluna. That roots of Vaccinium are infected by mycelium of the endophyte when growing in sterilised soil was overlooked by Stahl,—as more recently by Christoph in the case of Calluna,—because the formation of typical mycorrhiza is partially inhibited in the roots of both these species when growing in a sterilised medium. Under these conditions, the demonstration of mycelium in the mycorrhiza cells demands a more careful technique than was bestowed upon it by either of these observers

The interesting observations on conifers contributed by Prof Lewis confirm the view long held by the present writer, that the distinction between ectotrophic and endotrophic mycorrhizas is one of degree of infection only Many of the so-called ectotrophic forms yield evidence of the presence of intercellular mycelium when a suitable technique is employed This view receives further confirmation from the recent extensive researches of Melin ("Experimentelle Untersuchungen uber die Konstitution und Ökologie der Mykorrhizen von *Pinus silvestris* L. und *Picea Abies* (L.) Karst," *Sonderabd aus myk Untersuch und Berichte*, Bd. II., 1923, Stockholm).

At the same time, it must be pointed out that the presence of mycelium throughout the shoot tissues does not in itself constitute a proof of identity with the mycorrhizal fungus of the same plant Experimental proof of such identity has been obtained for Calluna and Vaccinium, but it is perhaps rash to assume, by analogy, that the same is true for *Picea canadensis* and other conifers

Prof. Lewis's allusion to "symbiosis" raises the question of the exact significance to be attached to this term. In my opinion the term "symbiosis" can be correctly applied to the relationship between flowering plant and fungus in mycorrhiza plants if it is used as originally defined by de Bary. Its use when *mutualism* is implied is justified only if supported by experimental evidence. Each case requires investigation on its merits.

M C. RAYNER.

The Nature of Verse.

THE experimental results reported by Prof. Scripture in NATURE of October 11, p. 534, are of course to be accepted as accurate, but they do not lead inevitably to his conclusions. He is dealing only with "the physical nature of verse," with verse "as it comes from the speaker" and passes to the hearer. Of this he gives a faithful and valuable account; but it is wrong to draw conclusions as to the nature of verse from an inquiry into only one aspect of it.

To express the rhythmical effect of verse Prof. Scripture uses a concept—that of the centroid—which deserves fuller recognition. He states that "The simplest English poetical line consists of a quantity of speech-sound distributed so as to produce an effect equivalent to that of a certain number of points of emphasis at definite intervals." Few will take exception to this, so far as it goes; but he draws the conclusion that verse is "purely a matter of rhythm; it has *no* metre. The usual scheme of prosody with feet, syllables, iambus, trochee, etc., is a fantastic fabric of fancy without the faintest foundation in fact."

A certain amount of poetical work makes no claim to be metrical, but apart from this it is untrue, even on Prof. Scripture's evidence, that verse "has no metre." If the centroids recur at definite intervals then they may be said to mark out measures, bars, or feet, the "point of emphasis" marking either the beginning or the end of the foot. There is no need for the feet to be conterminous with syllables, or to be cut off one from another as if the speech sound were not continuous, or to show any simple or indeed any fixed internal ratio between their parts Prof Scripture may object that this is not the *usual* scheme of prosody, with feet, syllables, etc., that he is attacking. But we may believe in metre without supporting the orthodox prosody of mid-Victorian days. That scarcely needs slaying thrice, although modern metricians who no longer accept it find the old schemes and terminology convenient to use for rough and ready purposes

A more important point is that Prof Scripture takes no account of the fact that the physical rhythm is the external manifestation of a psychological rhythm. One of his examples illustrates this. Whoever read the line from "Hamlet" for him to record evidently felt "is" to be more important than "that," and the record accordingly shows the arrangement of centroids to be

To be or not to be that is the question.

But many, if not most, readers would place the point of emphasis on "that"—

To be or not to be that is the question

the record showing a different arrangement of centroids

The nature of the sound rhythm depends on the nature of the mental rhythm with which it corresponds (or perhaps we may find that they are mutually dependent) Consequently, experimental methods, however accurately carried out, can by themselves reach no finality "The first step in the study of verse," says Prof Scripture, "must be the purely physical one of registering and analysing the air-vibrations" But even if this is so, it is not all We have also to inquire why the vibrations come to be arranged in that particular way The problem of metre is not a merely phonetic problem, for the effect of verse depends not merely on some stimulation of the senses, but on something that is a matter for apprehension on a higher or more complex level than mere sensation, on the *recognition* of some sort of recurrence.

EGERTON SMITH.

Krishnagar College, Bengal.
November 17.

The Origin of the Satellites of Mercury Lines.

INTEREST in the complex structure of the important lines in the arc spectrum of mercury has been revived by the suggestion of Nagaoka, Sugiura, and Mishima (NATURE, March 29, 1924) that the satellites are due to isotopes of mercury. The suggestion is based on the agreement of the wave-lengths calculated according to a hypothetical formula (similar to Kratzer's formula for the spectrum of hydrogen chloride) with

the measured wave-lengths. On the other hand, Ruark, Mohler, and Chenault attribute the fine structure of the lines to "transitions between components of complex spectral levels" (NATURE, Oct 18, 1924) They are satisfied that in the great majority of cases it can be proved that fine structures are not due to isotopy.

There are two conditions which must be satisfied by lines arising from isotopes (1) the intensities of the several isotope lines in the radiation from a thin layer must be in the ratio of the concentrations of the respective isotopes, (2) the radiation from the end of a long column should be distinguished by the equalisation of the brightness of corresponding lines when the column is sufficiently long for the lines to be "saturated" We have directed attention to this point in a recent paper (Proc Roy Soc. 105, p 527, 1924)

The application of the first test is difficult, but the second is possible in some cases In the case of 5461 Å all the satellites approximately satisfy the second condition, with the exception of one, namely, — 024 Å In the long column radiation the satellite — 024 Å is the brightest line of the group, and all the others are so nearly of equal brightness among themselves that the distinction, based on difference of intensity, between "main line" and "satellite" is lost. It appears to us that if the components of this group are to be attributed to the isotopes of mercury, the line — 024 Å must be excluded from the list. It appears, however, from the note of Nagaoka and his co-workers that they include this line in the isotopic group of 11 satellites, which, together with the main line, make up the whole group of 12 constituting 5461 Å

In the case of the two yellow lines 5791 Å and 5769 Å, these authors state that the observed wave-lengths of the satellites of 5791 Å agree with the calculated wave-lengths, whereas there is no agreement in the case of 5769 Å We, however, find that the side components of 5769 Å can be reversed on a continuous background, and that in long column radiation they approach the main line in brightness, whereas in the case of 5790 Å, we have been able to reverse the main line only, and the ratio of emission to absorption is greater for the satellites than for the main line Thus the components of 5769 Å appear to satisfy the second condition we have mentioned above, while those of 5971 Å do not

E P METCALFE
B VENKATESACHAR

Central College, Bangalore,
University of Mysore,
November 27

Chemical Combination of Helium.

THE views of Franck on the existence of a metastable form of helium capable of forming chemical compounds have led me, at the suggestion of Sir Ernest Rutherford, to search for such compounds. The experiments carried out during the past year indicate the existence of helium compounds of a different type from the mercury helide described by J. J. Manley in NATURE of December 13, p. 861.

I have examined mixtures of helium with the vapours of mercury, iodine, sulphur, and phosphorus under the influence of electron bombardment and in the presence of surfaces cooled by liquid air I find the helium disappears almost completely at a rate much greater than that observed under the ordinary conditions in a discharge tube Solid substances, which I believe to be compounds of helium, were condensed on the cold surface together with an excess of the other element used.

Numerous experiments were carried out which showed that the effect was not due to mechanical occlusion or adsorption. In the absence of a cold surface, a slow and very slight disappearance occurred, and the helium could only be recovered by heating the apparatus to 300° C. Experiments showed that this absorption or mechanical occlusion of helium in condensed vapours was very slight.

The substances obtained have a vapour pressure of the order of 0·005 mm. of mercury at −185° C. On allowing them to warm up, they decompose very suddenly at definite temperatures, and the original amount of helium is recovered. In the cases of mercury and iodine, this temperature is approximately −70° C and for sulphur and phosphorus −125° C The only disappearance of helium above these temperatures was of the order to be expected from the experiments described in the preceding paragraph In appearance, the compounds of mercury and iodine are not like the pure elements, but at the temperature of decomposition the appearance changes to that of ordinary deposits In the case of phosphorus, when the reaction is allowed to proceed, the deposit is yellow, but, if no reaction occurs, red phosphorus is obtained as might be expected since the vapour passes over a hot filament

Preliminary determinations of the velocity of reaction have been carried out, and further work on this point is in progress, as well as experiments which it is hoped will determine the composition of the products E H BOOMER.

Cavendish Laboratory,
Cambridge,
December 16.

Double Rainbows.

WHEN the source of light is at a practically infinite distance, as in the case of the sun, the position of the bow is determined only by the positions of the source and of the observer's eye When, therefore, a bow is seen double, there must be two effective sources. The phenomenon described by Mr. Deodhar in NATURE of December 13, p. 860, cannot be explained as due to two parallel rain showers Moreover, his laboratory experiment with a source of light near to the observer would be likely to mislead him, for the conditions brought about by the near approach of the source are greatly and strangely modified (see NATURE, Vol. 105, May 27, 1920, p. 389).

Two bows of the same radius but about two centres, one above the other, have been observed by the writer, the lower cast by the sun and the upper by the image of the sun reflected in a surface of water In the case described by Mr Deodhar the sun was low and rising, and if the upper bow were due to a reflected image the two bows would gradually separate and not approach one another as he observed them to do

Mr. Deodhar does not state in his letter whether he looked round to observe the sun at the moment. Perhaps he would have seen a second source of light, such as a small patch of brilliantly illuminated cloud near to and approaching the sun Another explanation that may be suggested is the duplicating of the sun's image by mirage or some other form of abnormal atmospheric refraction. The low altitude of the sun would favour this latter explanation.

C. O. BARTRUM.

32 Willoughby Road, Hampstead,
December 15.

Historical Aspects of Malaria.[1]

By Dr ANDREW BALFOUR, C.B., C.M.G

MALARIA AS A DESTROYER.

DESPITE all the knowledge gained by able and devoted men, despite the application of that knowledge in certain places, despite heavy expenditure, malaria remains one of the great killing and crippling diseases of the world. Let us consider some of the ancient records and see what they have to tell us First of all, however, it seems fitting, in the centenary year of Byron's death, to recall the last lines from his "Destruction of Sennacherib"—

> And the might of the Gentile, unsmote by the sword,
> Hath melted like snow in the glance of the Lord

It is of interest to note that Genovese, an Italian author who recently wrote an informative paper on "La malaria castrense"—that is to say, malaria in camps and incidentally in armies—is inclined to attribute the destruction of the Assyrian host to malaria It is of course impossible to be certain, but Palestine, then as now, was an intensely malarious country, and it is conceivable that a severe outbreak of malaria decimated the Assyrian army. If so the poet unwittingly approached the truth when he wrote

> For the Angel of Death spread his wings on the blast—

though, as only the female mosquito attacks man, *her* wings would have been nearer the mark The rapidity with which the destruction was accomplished as recorded in the Book of Kings is against malaria, but we need not take too *literally* the single night in which it is said that a hundred fourscore and five thousand perished.

Although it is impossible to speak with certainty, there is little doubt that ancient Egypt was heavily plagued by malaria. We know that it was a country full of great marshes, the remains of some of which persist to the present day, and the following passage from Deuteronomy has been cited as evidence of the existence of paludism "The Lord shall smite thee with a consumption and with a fever and with an inflammation and *with an extreme burning* and with the sword and with blasting and with mildew; and they shall pursue thee until thou perish"

It is not, however, until we turn to ancient Greece that we obtain anything like a true picture of malaria and its ravages. In "Malaria and Greek History," which Mr. W. H. S. Jones, of Cambridge, inspired by Sir Ronald Ross, wrote and published in 1909, it is claimed that malaria was the cause of Grecian decadence. Mr. Jones speaks of the malaria blight which fell upon many fertile districts of Greece about the fifth century B.C. He quotes the Wasps of Aristophanes to show that malaria, the "nightmare" disease as it was called, had invaded Attica, and that fevers and agues throttled the sires and grandsires of the Athenian people. He cites the treatise of Hippocrates on Airs, Waters and Places as proof that the father of medicine was very familiar with the dire results of malaria cachexia, with that chronic malaria which even to-day is wellnigh as hard to cure as it is to endure. Those who drink the water of marshes, said Hippocrates, have large spleens, but thin faces and shoulders. Again, after referring to the lowering of the birth-rate, owing to the physical condition of the women and the shortening of the span of life, he describes in a famous passage the people who dwell in low meadowy and hot districts, where the winds and waters are warm, as neither tall nor well-built, but short, fleshy, dark-haired, dark-coloured and bilious They are neither courageous, nor of great powers of endurance. The stoutness to which reference is made is doubtless perplexing, for the malarial cachectic is usually emaciated, but it may imply that the sufferers were œdematous or in an unwholesome condition There can be no doubt that in 400 B.C. large tracts of Greece were in a miserable state owing to malaria, while 200 years later the assertions of Polybius as regards the rapid depopulation of the country owing partly to emigration, partly to a heavy mortality, point, in some measure, to its malign influence.

In the olden days marshes surrounded Athens The Stadium was a swamp, and armies fighting round the capital suffered enormous losses It is recorded by Polyænus that Clearchus the tyrant, with the view of getting rid of a number of riotous and disaffected citizens, conscripted them to invest a town "in the dog days"—that is to say, in the summer—and made them encamp in a marshy plain "ill-ventilated and full of marshy pools," while he and his mercenaries occupied the surrounding hills The effect was rapid and terrible, for the wretched men were wiped out by malaria It is true that Dr Cardamatis, of Athens, a well-known malariologist, does not agree with the conclusion reached by Mr Jones, for he thinks the English author has overlooked the remarkable reclamation works carried out by the ancient Greeks, notably by the Minyans on Lake Kopais He attributes the decay of the nation to other causes than malaria, but, be that as it may, the destructive agency of the mosquito-borne disease is well exemplified in ancient Greece, where towns were actually given names signifying "heavy sickness" Some of these names, such as Kounoupia, Konopina, and Kounopitsa, exist to-day.

There are some who would attribute the decline and fall of Rome to the evil influence of malaria, and certainly in olden days the environs of the imperial city were described by classic authors, such as Cicero and Livy, as "Pestilentia" Tacitus states that Gallic and Germanic troops suffered severely by camping in the insalubrious neighbourhood of the Vatican, where the lands were covered with stagnant water and the air was unwholesome. Even at the present day a suburb of Rome is called "The Vale of Hell," and three-quarters of its inhabitants are saturated with malaria.

Genovese, already quoted, refers again and again to the havoc wrought by malaria amongst armed hosts. Many large Carthaginian armies faded "like mists before the wind" because of it, and the losses amongst the Roman armies in the wars against Hannibal must have been incalculable.

It is Banister the American, however, who brings things nearer home, for he declares that Brennus would undoubtedly have taken the Capitol at Rome had he

[1] From a discourse delivered at the Royal Institution on Friday, May 23.

not, in A.D. 208, lost in "Caledonia stern and wild" 50,000 out of 80,000 men from malaria.

So much for Europe long ago. A single example may be culled from the tropics, from the fate which overtook the people who built the lost cities of Ceylon, those wonderful ruins in its north central areas. Lucius Nicholl, of Colombo, believes, with some reason, that their ruin was occasioned by malaria. He points out that the ancient cities really owed their existence to the field labourers, who, by constructing tanks and by rice cultivation, made the country prosperous and self-supporting. It is reasonable to assume that the stress of devitalising diseases would fall upon them, and as the climate and the rainfall have not altered, there is every probability that malaria was imported from India with dire results

However interesting and suggestive these records and experiences from ancient times may be, they scarcely appeal so forcibly as those from later periods Take the extermination in the Roman Campagna in 1167 of the finest army ever commanded by Frederick Barbarossa. So rapid and awful was the destruction that the writers of the time have represented the disease as a "black cloud which covered all the valley near the Monte Mario, where the army was situated, and poisoned the air." A heavy rain had fallen in August and converted the place into a boundless swamp; then followed an enervating spell of hot weather, and an irresistible invasion of the wretched troops by fever. "Obscure soldiers, nobles and illustrious prelates laid down their lives there," says Genovese. The flower of a nation was exterminated, while in the same outbreak Rome lost some 20,000 inhabitants. Throughout the Middle Ages there were many deadly epidemics of the disease, like that of 1557–58 in England.

Let us fare to the tropics once again, and see how malaria wrecked high hopes and a well-found expedition when the ill-fated Scottish Darien scheme came to nought The settlers landed on a pestiferous spot of land in 1698 and speedily came to grief, mainly, if not wholly, by reason of disease There can be little doubt that malaria was the chief malady which overcame them, though yellow fever may possibly have been operative At any rate, the "Memoirs" of the Rev Francis Borland, who was one of the chaplains to the second portion of the expedition, leave one in no doubt that mosquito-borne fevers wrecked the enterprise. Two hundred years later a similar want of skill, due chiefly to lack of knowledge, occasioned, not far from Darien, a similar melancholy tragedy when the French failed in their great endeavour at Panama. It must be remembered that, though yellow fever proved their main adversary, malaria wrought much havoc in their ranks. It was left to the Americans, the heirs to learning gained partly by others, partly by themselves, to triumph over malign local conditions.

I have spoken of camps and armies, but navies have also felt the weight of malaria; the British Navy has suffered from it time and again. Perhaps the most dolorous account of its ravages is to be found in the records of the forgotten Batavian endemic, as it was called, which occurred in June 1800, when we were fighting the Dutch in Java. The ships concerned were the *Centurion* and the *Daedalus*—historic names. Seamen, marines, and soldiers alike suffered. The place of tragedy was the small island of Edam, nine miles offshore from the low swampy grounds of Batavia, and the remarks of Shields, the naval surgeon who is the chronicler of the disaster, are highly suggestive. He speaks first of Onrust, a small island only three miles from the main, well cleared of trees, underwood and jungle, nearly flat and free from swamps and marshes. Speaking of the sick brought here from the ships blockading Batavia, he says:

"From the fœtid exhalations, which were conveyed by the land winds from the neighbourhood of Batavia, the sick were easily secured, by closing certain apertures in their apartments, till the sun dispersed the vapours in the morning; after which there did not appear to be any danger from the miasmata disengaged during the day Edam, on the other hand, though farther out of the reach of Batavian exhalations, is covered with trees, long grass and jungle, having a part of the island itself in a stagnant, marshy state. The buildings here were indifferent, and only one long ward could be found for the sick and convalescents, in consequence of which the latter class of patients experienced all those dire effects produced by the depressing passions, forever nurtured by the melancholy scenes of death, which this fatal spot too constantly presented to their view! Thus, in running from a doubtful danger, they precipitated themselves on certain destruction. In leaving Onrust (a cleared space) to avoid the effluvium of Batavia, weakened and diluted by a three miles passage from its source, they settled on the jungly and marshy island of Edam, where pestilent miasmata, in a concentrated form, issued from every foot of ground around them! The fatal effects which followed were predicted by an intelligent surgeon on the spot, but his suggestions were disregarded or overruled, *distance* from the main being held paramount to all other considerations."

I might trace the deadliness of malaria from the Walcheren expedition, which it ruined, to the Crimea, where it played havoc, and on to Macedonia where it, more than any other single factor, rendered the Allied Forces in the War comparatively impotent I might tell you of great epidemics in India, of its strangling hold on the West Coast of Africa, of how the Indians in Mexico suffer and die from it; of the appalling conditions at present existing in Southern Russia; but I prefer to take one great classical example of its powers for evil within recent times—its invasion of Mauritius. It is unnecessary to consider the rights or wrongs of the story generally believed—to wit, that in the late 'sixties of last century, African malaria-carrying mosquitoes were introduced from a sailing ship, multiplied exceedingly, found infected blood already present in the bodies of Indians from India or Creoles from Africa, and commenced spreading the parasite, and incidentally the disease. I would rather give one or two passages from a book on Mauritius by Nicholas Pike, who was American Consul at Port Louis in 1867–1868, and was an eye-witness of the scenes.

"Those who inhabited Port Louis," he says, "during the terrible mortality in 1867 and 1868 will never forget the sad spectacles the city presented daily. Fever! Fever! was the only word on every lip—the only thought in every heart. Mourning and desolation everywhere. Scarcely a person visible that did not wear the garb of woe. Song and laughter had ceased.

"Port Louis was once remarkable for the number

of pianos heard in every street in an evening, from the Erard's grand and semi-grand to the humblest cottage instrument.

"At this time it was literally 'The daughters of music were brought low and the voice of mourning was heard in the streets.' Funeral trains were met at every corner. Relays of men were kept busy night and day digging the graves."

I have seen these graves, mute witnesses to the severity of the outbreak, to the dire results of ignorance. For months an average of 200 people died per day in Port Louis, and scenes such as Pike describes were common.

Think of what all this means, and what the discovery of the malaria parasite, and of the method of infection by the mosquito, has meant, and how much more it would mean if only men and governments would act energetically and enthusiastically upon the knowledge gained. When Mauritius passed through its furnace of affliction, and 31,920 persons perished, Laveran was a student at Strasbourg and Ross a schoolboy at Ryde

We have dealt with malaria as a destroyer *en masse*, but before looking at the reverse side of the medal and noting how it has benefited mankind, let us see what it has done in the way of removing notable persons in the historical sense, some of whom at least were valuable assets either to the communities they served or to the world at large. Naturally enough it is difficult to obtain trustworthy records from the far past In those days the word fever covered, if not a multitude of sins, a great variety of febrile disorders, and it is only in a few cases that definite clinical evidence is forthcoming which enables us to say that so-and-so undoubtedly perished from malaria. Even in comparatively recent times accurate diagnosis was difficult, for malaria is a very protean disease, and cannot be definitely predicated without the use of the microscope Hence my examples are scanty and some are doubtful.

Alexander the Great conquered the world, but there is some reason to believe that malaria conquered him, aided by his excesses and his disregard of precautions. Vasco da Gama voyaged half round the globe, but he voyaged to another, and it is to be hoped a better, land at the bidding of the malarial plasmodium—at least so it has been said. Anyhow he died of fever at Cochin, and his fatal illness was probably malarial in origin. "The wisest fool in Christendom" was undoubtedly killed by malaria. He died of ague at Theobalds. One of his predecessor's stoutest, but not too reputable servants, the bold Sir John Hawkins, had his end hastened by, if indeed it was not actually due to, the same disorder. Oliver Cromwell also, who died of ague at Whitehall, yielded his life to the insidious attack of the malarial parasite. Whether Byron was a victim of the disease when he died in his beloved Greece is a moot point. Sir Ronald Ross is inclined to think malaria was not guilty in this instance.

Careful research might add other names to this brief list. One would expect that of the great explorers in the tropics some were wiped out by malaria, but I have not been able to find indubitable evidence in the case of the greatest of them.

Malaria as a Benefactor.

Until very recently it would not have been possible to adduce evidence showing any *direct* benefit to man from the disease malaria, but a surprising development took place a few years ago when Prof. Wagner-Jauregg, of Vienna, began to treat cases of general paralysis of the insane—the dreaded G P.I —by introducing into the blood of patients the organism causing malaria, thereby producing in these patients attacks of malarial fever He had noticed, as had others, the beneficial effects of febrile attacks in cases of general paralysis, and conceived the idea of inducing high temperature repeated at short intervals It occurred to him that this is what the malaria parasite accomplishes in its victims, and that it might be used as a curative agent. Although patients were treated on these lines so early as 1917, nothing was published on the subject until 1920, but the remarkable results obtained in certain instances, and the fact that, in most cases, distinct benefit resulted, led to extensive trials of the new treatment on the Continent, and later to its employment in Great Britain.

Ere now one malady has been used to combat another, but never before has a serious disease been utilised in therapeutics which, once its good work is accomplished, can be effectively and speedily controlled. This is possible in the case of malaria, thanks to quinine, which, so far as its introduction into Europe is concerned, we owe to a woman, the Countess of Chinchon. We are able also to select one of the three forms of malaria which is the least dangerous, but naturally care must be taken that this use of the malaria parasite as a drug does not result in its dissemination by mosquitoes from those treated by it In Great Britain there is little danger of such an accident, but in Germany serious attention has been directed to it.

The method, promising though it be, is still in its infancy It is possible that it may be applicable to other diseases of the central nervous system, at least those due like G.P I to a specific spirochæte, but great care must be exercised, and this new therapy should be in the hands of experts familiar with the malarial plasmodium, and able also to gauge its effects. Those effects, it may be said, are not exercised on the other parasite, the spirochæte, nor does the high temperature affect this invader The action appears to be on the damaged tissues of the brain itself; but the precise mechanism is still obscure. If, however, malaria proves itself able to cope with locomotor ataxia, with disseminated sclerosis, and with paralysis agitans, then indeed it will be hailed as a benefactor, and be considered as having in some small degree made amends for its past atrocities.

Indirectly malaria has undoubtedly aided the human race. Mr. Jones ingeniously argues that it was responsible for the increased respect shown for women in the later days of ancient Greece, and cites the New Comedy (320–250 B.C.) as proof thereof. He considers that the value of women as nurses was made apparent by it, and that, as the wife was usually the nurse, endemic malaria vastly increased her duties and importance

The chief indirect beneficial action of malaria is to be found, however, in the way it has stimulated men to thought and action. From the earliest days mankind was forced to exercise ingenuity in protecting themselves from fever. Egyptian and Cretan fishermen slept under fishing-nets folded again and again until their meshes were small. They believed they were

excluding miasmata, but they were really keeping mosquitoes at bay. Yet so little is history regarded, perhaps because Herodotus wrote of this habit of Egyptian fishermen as a mere curiosity, that we find Prof. Traill in 1837 stating that the proposal to defend the body against marsh miasma by the interposition of gauze nets was first made by Rigaud de l'Isle in 1817, and recording that Brocchi had taken up the same idea, and averred that he had successfully employed it against malaria

Malaria inclined men from very early days to attribute the infection of fevers to mosquitoes or other biting insects Susiuta, an Indian physician who probably flourished in the fifth century B.C., taught this truth, and there is a picture of him expounding it to an Eastern potentate

Varro and Columella at the time of the Christian era associated mosquitoes with insects bred in marshes; but perhaps the most remarkable announcement was that of Lancisi, who, in 1717, stated that marshes were the cause of the fever owing to the transformation of minute worms into "stridulous culices," and that the poisoned animals kill, not by the wounds which they inflict, but by infusing a poisoned liquid through the wounds The Abbé de Fortis, writing of his "Voyage in Dalmatia" in 1774, refers to his meeting with an ecclesiastic who suspected that fevers were due to insects, the infection being derived from corpses or poisonous plants, and who thought that miasmas might be conveyed in this manner The conjecture, says the Abbé, is at least ingenious

So it went on with such protagonists as Nott the American, Beauperthuy the famous French Creole, Finlay of Havana, and King, the soundest of them all, reasoning and arguing in favour of the hypothesis and none paying much attention to them Yet malaria had taught benighted barbarians the lesson and they had accepted it Richard Burton in his "First Footsteps in East Africa," published in 1856, states that the people of Zayla in Somaliland believed that mosquito bites occasion deadly fevers, and says that the superstition (save the mark!) probably arose from the fact that mosquitoes and fevers became formidable about the same time

But malaria led also to closer and more scientific reasoning The ancestors of the malaria parasite were probably coccidia, tiny protozoa inhabiting the cells lining the wall of the intestine Some of these, naturally enough perhaps, got a little discontented with their surroundings, changed their habit of life, and eventually found a more congenial habitat in the red blood corpuscles Now Richard Pfeiffer, a trained observer, had been studying the coccidia of rabbits in 1889–90. He noticed that these parasites not only multiplied within their host, the rabbit, but, in a special resistant form, provided for their transference to another rabbit once they had got outside the body of their original host He recognised that the multiplication of the coccidia in the epithelial cells of rabbits and that of the malaria parasite in the red blood cells of man was a very similar destructive process, and thought that possibly the malaria parasite, like the coccidium, might have two cycles of development. If so it would have to get outside man's body. Provided it did not produce any resistant form to enable it to withstand the dangers it would encounter in the wide, wide world, say in soil or water (and such a form was unknown), he considered that it might make use of some insect in which, sheltered and comfortable, it could undergo the second, or as it is called exogenous, cycle of its development. It could then, as Koch had suggested to him, get back to man through the bite of some blood-sucking insect

This, as events have shown, was a prophetic utterance, but it was linked up with the earlier work of the great Sir Patrick Manson, who, long before, working in Amoy, far from books and skilled help, had proved that a mosquito served as the intermediate host of a human blood parasite, that tiny filarial worm, to the presence of which in the human body the disease elephantiasis is attributable He showed that the mosquito was a necessary link for the fulfilment of the life-cycle of the bloodworm This was a new conception in pathology of which both Koch and Pfeiffer were aware. Still this does not detract from the merit of Pfeiffer's carefully reasoned hypothesis. Neither he nor Koch, however, followed up the matter The solution of the problem was left to Ross, who, at Manson's instigation, took up the work in India, and after manifold trials and tribulations emerged victorious Certain Italian observers also contributed notably to our knowledge, and Ross himself, not content with mere scientific work, at once turned it to practical account.

Malaria, then, benefited man by stimulating him to undertake work for its own destruction, surely rather an altruistic action, and not unlike that of the medical profession itself. This stimulation has had other and far-reaching results, for, more or less as a direct outcome of the discoveries regarding malaria transmission and prevention, attention was directed to all kinds of protozoal and allied diseases. The American work on yellow fever was, in fact, the sequel to the researches of Ross, and an immense stimulus was given to the scientific study of tropical medicine and hygiene. One of the latest developments has been the application of electricity for the purpose of destroying mosquito larvæ and pupæ. Montellano, of Argentina, introduced the method of electrocution which is now being given an extensive trial.

Not only did malaria excite inquiry and interest, but education of the public was also found needful, and propaganda were launched broadcast. Man's ingenuity was stimulated afresh, for it was by no means easy to explain to lay audiences the intricate life-history of the malaria parasite; and further, his enthusiasm was aroused in an endeavour to present the problems of preventive work in an attractive and effective manner. Here it is that the Americans have forged ahead. Malaria is a very serious problem throughout the Southern United States, and indeed has been the reason why some of them have, until lately, been backward and depressed. The Americans are a practical people, and moreover are easily fired by that idealism which, if well regulated, so often spells success. Hence they have spared neither time nor money in combating malaria and bringing before the public by cinematographic films and other educational means the mysteries of the life-cycle of one of man's greatest foes, the measures taken to defeat it, and the results of a campaign well and truly waged.

Fuel Oil Resources of the Future.

By H. B. MILNER.

PUBLIC attention has once again been directed to the vital question of the world's resources of petroleum, in a paper read before the Institution of Petroleum Technologists by Prof. A. W. Nash and Mr. H. G. Shatwell on December 2, and further by a column having reference to that communication in the *Times* of December 3. The object of the paper is to allay uneasiness existing in the minds of many with regard to the adequacy of future oil resources

The argument requires that before justifiable fears are entertained we must be satisfied that all free petroleum in the earth has been located, that the problem of the origin of petroleum has been solved, and that "oilfields can be discovered and not simply located as a result of surface workings by local inhabitants." Alternative to natural mineral oil are "the abundant stores of bituminous material from which oil can be obtained by destructive distillation," these being oil shales, cannel coals, torbanites, lignites, peat, and coal.

With regard to the first point, it is maintained that outside America the search for oil has not been carried on diligently, and the implication is that, following precedent in the history of the American oil industry, more fields should be developed in other countries Then, the problem of the origin of petroleum not having been solved to general satisfaction, it is argued that it is impossible to state definitely that oil is not in process of formation at the present time. The third point is obscure both in definition and in amplification, though it is implied that improved technique is necessary in the initial stages of oil exploration The arguments in favour of the development of alternative fuel resources are not new, though great stress is laid on the commercial possibilities of "bergimisation" of coal and oil as a promising method of obtaining a substitute for natural petroleum.

It is difficult, despite the good case made out by the authors for peace of mind in connexion with future oil supply, to share fully their optimism, because while some agreement may be accorded with the facts they adduce in support of their opinions, their interpretation of the position and the conclusions they reach, since they are based on no new data, are open to question as much from economic as from technical points of view.

Misapprehension concerning the future of oil-fuel supplies was first of all felt and voiced, not by an irresponsible section of the community, but by experts both in the United States and in Europe, who realised the true drift of events. Far-sighted people, from an examination of the position from every angle—national, technical, economic—gradually came to see that if production did not keep pace with an ever-growing consumption, a most serious position would arise, probably within the course of two decades or so. Uneasiness spread, therefore, despite insistent press contradictions, instigated by interested persons, who did not hesitate to write up glowing accounts of a contemporary "oil age," and to quote misleading statistics to prove their optimistic contentions. Thus the industry and the public were entitled to an unbiassed knowledge of the facts, and also to considered and authoritative judgment on the position, either as a clear warning to be prepared for the worst, or as a vindication of the light-hearted optimism expressed in some quarters. The authors have therefore done well in bringing the matter once more to the front, even though we cannot agree with the reasons they consider sufficient to disarm fear for the future.

First, it is, we agree, reasonable to believe that all available petroleum has not yet been located; it would indeed be a poor outlook if this were so. But it is a question of magnitude of resources to be tapped, not merely the discovery of several comparatively small oil-pools. We have to ask ourselves whether, from broad geological knowledge of the world, there exist accessible regions outside the United States, where geological conditions are likely to favour the preservation of oil deposits on the vast scale which has made the industry in that country, and latterly in the world, what it is? Can we point to a second Pennsylvanian, Mid-Continent, or Californian region anywhere with any degree of scientific possibility? It is difficult to do so. It is, of course, possible to predict many localities likely to yield a future oil supply, on a par with, say, Persia, or Sarawak, at the present time, but it is not easy to visualise the existence of oil-pools the collective exploitation of which will determine an ultimate supply on the scale at present requisite, or likely to be demanded in the near future, if and when the United States with Mexico cease to yield 80 per cent. of the world's total output

Secondly, we may agree with the authors that the mode of origin of petroleum still remains debatable, despite more than thirty years of philosophy, but even if the problem were solved to universal satisfaction to-morrow, would the knowledge lead us to the location of deposits at present forming, and would such deposits be likely to have immediate economic value even if they were found? Whatever theory be advanced to account for the origin and accumulation of petroleum, the geological time-factor seems to be an inevitable influence in the mechanism, and yet we are asked to contemplate the prospect of contemporary petroleum, ripe for use, if not just at the moment, at least within the next few decades! An accepted solution of the genesis of petroleum is desirable for many reasons—mainly scientific—but the immediate economic significance of such a solution if arrived at, as indicative of a new line of field-investigation, is difficult to follow.

Thirdly, the authors suggest that mere geological examination of potential oil-bearing territory is insufficient, and should be accompanied at the outset by a drilling staff "to drill for geological information and not for oil." Where is the philanthropic company which can be persuaded to finance such a proposition? Further, the platitude is expressed that the science of geology of petroleum is an inexact one; since geology itself cannot be classed as an exact science, obviously a particular application must, *a priori*, be inexact But is it a whit more precise, as is implied, to encourage wholesale "wild-catting" of a kind which, while admittedly advisable from the purely technical aspect of field-geology, might only result in more failures to find oil, certainly in a heavier initial expenditure which the

average company director would never agree to incur, not even in these enlightened days of intelligent directorates? If the geologist is to be of any use at all in locating oil deposits, his work must precede exploratory drilling, for economic, if for no other reasons.

The authors also review the existing position of oil supply and mention more particularly possibilities in Persia. In this connexion, while sharing their opinion, we may be allowed the remark that even if Persia doubles her production in the next year or two, it would only represent 5 per cent. of the world's output at the present rate. They also stress the potentialities of the Canadian Athabasca tar-sands, a proper utilisation of only 25 per cent. of which would, they say, remove apprehension regarding the future. We refer them to the recent report by S. C. Ells (Bituminous Sands of Northern Alberta, 1924), in which he states (in reference to tar-springs) that "in no instances are they themselves of commercial value as a source of bitumen. They have, at times, been regarded erroneously as a definite indication of the presence of petroleum pools." Later, summarising several processes devised for producing oil from these tar-sands, he says, "The results of this work are as yet inconclusive."

A further "off-set" to shortage of supply is the possibility of mining for recoverable oil from abandoned oil-fields by shafts and galleries, as at Pechelbronn; this principle, apart from the human factors involved, may be economic with shallow sands in some cases, but what of oil-sands lying between 3000 and 5000 feet below the surface. would the method be practicable, and does it therefore help the solution of the difficulty?

Lastly, we reach the question of alternative fuel resources, and here, while the authors are to be congratulated on the way they have marshalled the possibilities of shales and coals, they should in fairness have laid more stress on the technical difficulties at present in the way of utilising these resources on a satisfactory commercial scale. The world's known resources of oil-shale are now generally appreciated, but the estimates given by Alderson and others as to the amount of oil recoverable from them are quite fictitious until suitable retorts and processes are devised for treating them economically, while apart from any other difficulty, desulphurisation of shale-oil and high refining losses still remain in many cases thorny impediments to development, as in Great Britain.

The difficulties concerned with coal and allied carbonaceous material as a source of oil are similarly those concerned with large-scale treatment for commercial supply. Low temperature carbonisation is, from the economic point of view, a process which has yet to be extended under modern conditions of fuel supply and efficiency. Even if successful, oil thus obtained, as the authors admit, can never adequately replace petroleum products. The "berginisation" of coal and oil, regarded by the authors as being of great promise, is in an experimental stage, and much ground has yet to be covered before the application is a practicable one from a commercial point of view. This process consists in heating in the presence of hydrogen a mixture of powdered coal containing less than 85 per cent. of carbon, with mineral oil or tar oil at high pressure (100 atm.) and temperature (400°-430° C.), when a liquid product closely resembling petroleum results. It may be pointed out that unless the liquid product is capable on refinement of yielding a range of products which will take the place of petrol, kerosene, lubricating oil and fuel oil, the process loses at once in value as a means of producing artificial fuels. At present we have little trustworthy data concerning either the refinement or the quality of such "berginised" oil.

Thus the whole question remains in an unsatisfactory position, and it cannot be said that a critical examination of the authors' thesis advances things much further. We endorse, as every student of science will do, their insistence on the need for research, not only for posterity, but also for our own sakes. Conservation of petroleum resources will automatically come, whether we urge it or not, since for strategic reasons alone the United States will ultimately have to limit its exports of oil, and that, too, within the next two decades, if further large supplies are not forthcoming. Once the United States decides on that policy, Europe and all other countries dependent on it for the larger proportion of their oil-fuel requirements will have to face the inevitable, and either economise in the use of petrol and petroleum products, or provide some alternative, but probably in the long run, far less convenient fuels and lubricants.

Hence the keynote to the situation may be summed up in the word economy. The present heavy-handed use of petroleum results from a general impression that there is plenty more where the present supply comes from, an extravagant idea inculcated by the same policy responsible for recent deplorable overproduction and wasteful consumption. If the industry, by adopting in the future the practice of husbanding existing resources and by straining every scientific nerve to a higher technique in production, refinement and utilisation of oil-fuel, thus sets the example to the public, the public itself will be educated: Decline in cumulative production in such circumstances will be slow; the full and beneficial effect of each new discovery of an oil-pool, however small, will also have time to operate, and the gaining of time in one way means that the chances of developing new schemes of alternative fuels, as outlined by the authors, are more likely to meet with success, at all events as commercial propositions.

Some people hold that we should enjoy the gift bestowed on our own generation, the privilege of living in an "oil age," and leave posterity to take care of itself. This is neither a credit to contemporary knowledge, nor is it in keeping with the best traditions of scientific progress. We owe it to ourselves to face the situation as repeatedly exposed by David White, Pogue, and others qualified to judge, and whatever position may ultimately be created by a shortage of natural petroleum, we have to see that we are not unprepared to meet the contingency either through lack of foresight or of initiative in perfecting substitutes. But we have also to realise that the prospect of supplanting petroleum by alternative, artificial fuels is confined largely to the realm of experimental possibilities; merely to define the possibilities is not necessarily to remove the qualms which still exist in the minds of not a small section of workers in the oil industry.

Current Topics and Events.

IT is a biological commonplace that every species of animal (man included) tends to increase in numbers if left free to propagate without restraint. This restraint is, however, always forthcoming when the population reaches a certain degree of saturation, and in the case of the human race it has in the past taken three forms, namely, war, famine, and pestilence. During the fourteenth century there were seven famines in England, in which the people died like flies, and towards the close of the century the Black Death wiped out three-quarters of the population. We are familiar with the ravages of the Great Plague in London in 1666, during which 100,000 people died, but few realise that in the preceding century there were two similar visitations, and in the earlier one, which occurred in Elizabeth's reign, 65,000 people died. The Queen and Court fled to Windsor, and the Queen had a gallows erected in the market-place, and gave orders that every Londoner who appeared in the town should be hanged!

WITH the development of our social sense, which is the real measure of our advance in civilisation, the suffering and sorrow involved in these calamities have become abhorrent to us, and a certain proportion of our population, chiefly the better educated members of it, have learned so to limit their families that they are able to give to each child its proper share of care, food, and affection. But the greater part of the population, including most of the manual workers, are without this knowledge; and amongst them the lowest, poorest paid, and least skilled are the most prolific. The Walworth Women's Welfare Centre (153A East Street, Walworth, S.E.), the annual report of which has recently been received, was established with the object of teaching the poorer women harmless means of preventing conception, so that the births may be properly spaced and the children given a chance of healthy development. A distinguished Dutch medical man, Dr. Jansen, in a book entitled "Feebleness of Growth," has given reason to believe that in successive children produced by rapidly succeeding pregnancies, there is a progressive physical degeneration manifesting itself in stunted growth and deformities of various kinds. It would seem that birth-control should ultimately replace natural selection as a limiting factor in human affairs: but if it is confined as at present to the best elements of the population, it must cause the deterioration of the quality of the race. The aim of the Walworth centre and of the newly established centre in North Kensington is to spread the knowledge amongst those who need it most.

THOUGH to-day some 2,000,000 tons of shipping are propelled by internal combustion engines of the Diesel type, a new chapter in the history of the motor ship may be said to have been opened with the recent trials of the M.S. *Oorangi* built by the Fairfield Shipbuilding and Engineering Company of Govan for the Union Steamship Company of New Zealand. The *Oorangi* (the name is the Maori for Mount Cook) is the first large and fast passenger vessel to be fitted with Diesel engines. The ship is 23,000 tons displacement, 600 feet long by 72 feet beam, and will carry about 1300 passengers and crew and a considerable amount of cargo. It is designed for the long run from Vancouver to New Zealand and Australia, on which it is expected that an average speed of 17½ knots will be maintained. The main interest lies in the vessel's machinery. There are many types of Diesel engines being produced to-day, but the engines of the *Oorangi* are of the Sulzer type, two-stroke, single-acting, as developed by the famous Swiss firm of Sulzer Brothers of Winterthur. There are four sets of main engines driving four shafts, each set having six cylinders 27½ inches diameter, 39 inches stroke, the whole 24 cylinders developing some 15,000 B.H.P., equivalent to 19,750 I.H.P. The air compressors for supplying the air, at 1000 lb. pressure, for injecting the fuel are worked off the main engines, while the low-pressure air supply for scavenging is obtained from three turbo-blowers driven by electro motors. There are also two electro motor-driven high-pressure air compressors for supplying the starting air when manœuvring in and out of port, while the electric power installation for the ship consists of four 350 kw. generators driven by Sulzer-Diesel engines of 420 B.H.P. Some of the auxiliaries in the ship, such as the refrigerators and winches, are driven by steam supplied from two ordinary marine boilers burning oil. The ship carries about 3000 tons of oil fuel, which is sufficient for the round voyage between Vancouver and Sydney. As pointed out by Engineer-Admiral Sir George Goodwin in his Hawksley Lecture to the Institution of Mechanical Engineers on November 7, there are many considerations to be taken into account when deciding upon the type of machinery for any particular ship, and the performances of the *Oorangi* at sea will be followed with great interest.

THE value of an international language for promoting amity among nations, and its obvious advantages for use in international trade, have been much emphasised by those who are convinced of the practicability of such a project, but its presumptive value to men of science has, perhaps, not yet received due attention. The work of a large number of scientific and technical societies is severely handicapped by the greatly increased costs of printing and publication, and the adoption of a single language for communicating abstracts from scientific literature, as well as for papers and treatises of exceptional importance, would undoubtedly effect economies in money and effort. In a recent issue of the Proceedings of the American Philosophical Society (vol. lxiii., No. 1), Prof. R. G. Kent, of the University of Pennsylvania, makes a thoughtful contribution to this subject. After referring to the use of Latin by scientific investigators from about A.D. 1500 until 1775, and to the recrudescence of national feeling and national languages since the War, the author declares that the language burden has now become too great

even for the professional philologist and *littérateur*. He discusses the merits of the chief languages that have been suggested for international use, and comes to the conclusion that Latin is best for scientific purposes. Latin has a vocabulary that is essentially international, and a technical terminology which is already very wide and capable of easy and indefinite extension. Although ease of acquirement and brevity are valuable characteristics of an international language, a recognised and unquestioned standard of meaning is even more important. Latin has an objective standard of word-meaning, and by reason of its terminations, word-order, and moderate use of auxiliaries, it allows of complete precision in indicating the relations of words to one another, it is reasonably phonetic; it is still used for constructing new words required in science; of all non-native languages, it is most studied in European and American schools, and its use would not inflame international jealousy. Prof. Kent advocates the use of a simple Latin, *i.e.* one with short sentences and few clauses, together with a slightly increased number of prepositions. Thus modified, he thinks that Latin would stand supreme as a means of conveying scientific thought to an international public.

At the last meeting of the Newcomen Society held on December 17, another valuable contribution was made to the early history of mechanical engineering by Mr Forward in a paper on "The Early History of the Cylinder Boring Machine." The lathe, the planing machine, and the boring machine have all been developed into very powerful and accurate machines, but some of their principal features can be traced back to the pioneering machines. It was the steam engines of Newcomen, Smeaton and Watt which created the demand for cylinder-boring machines, and one of the first is that described by Smeaton as seen at the Carron Ironworks, but it was as imperfect as Watt's "Beelzebub" itself. It was the well-known ironmaster John Wilkinson who first used a long stiff cylindrical bar fitted in bearings and provided with a cutter head of large size which could be traversed along the bar by means of a rack and pinions. It is possible the old boring bar at the Science Museum, South Kensington, was one of Wilkinson's earliest and was used at Bersham. Another improvement was the use of a screw instead of the rack, but it is not certain who made this important addition. Among the engineers of that day was Matthew Murray of Leeds, and it may have been due to him. In speaking of the making of the screws, Mr. Forward quotes an interesting passage from T. Gill's "Technological and Microscopical Repository" of 1830, showing how the lines for the screw were first produced on the bar, how a shallow screw thread was cut by hand, and how this shallow screw was used for completing the cutting.

A report by Mr Leslie Armstrong on recent results obtained by the joint committee of the British Association and the Royal Anthropological Institute for the exploration of caves in Derbyshire appeared in the *Times* of December 22. An undisturbed occupation site at Creswell Crags, opposite a cave, known as Mother Grundy's Parlour, at the eastern end of the ravine, has yielded rude implements of quartzite, more than 1500 flint flakes and implements, a number of bone tools, and numerous bones of pleistocene animals. More important, however, are examples of palæolithic art in the form of engraved bones, one a spirited drawing of a reindeer, another a part of a bison with the head, and a third fragment too small for identification. The only other undoubted example of palæolithic cave engraving from Britain is that of a horse's head from the Robin Hood Cave, also at Creswell, found by Sir W. Boyd Dawkins in 1876. The earliest implements—flakes and hand-axes made from quartzite pebbles of late Acheulean form—were associated with remains of cave lion, cave bear, and hyæna. They represent not only the earliest occupation of Creswell, but also the extreme northward extension of early palæolithic man in Britain. A considerable interval elapsed between this and the next occupation, which belongs to the Reindeer Period. In this stratum were flint tools of Upper Aurignacian type, the engraved fragments of bone, and tools manufactured from reindeer antler and bone. A hearth or fire-hole was scooped out in the basement bed and ringed with flat stones. Not only does the evidence from the cave earth here indicate continuous occupation from late Aurignacian to Azilio-Tardenoisian times, but it also supports the view which challenges the existence of true Magdalenian culture in Britain, and maintains that there was an independent development of culture here which was free from intrusive Magdalenian influence.

The December issue of *La Science Moderne* contains an article by M. Reverchon on "L'Evolution de l'Horlogerie." M. Reverchon points out that the mechanical clock was the gift of the middle ages, and its development belongs to the last six hundred years. One of the first clocks made was that constructed for the Cathedral of Beauvais, but the oldest clock still going is that in the Science Museum at Kensington. The fourteenth century saw many cathedrals supplied with clocks. All of these were fitted with the verge escapement—the first of all escapements—the inventor of which is unknown. "Nous sommes ainsi reduits à le saluer comme le soldat inconnu de la chronométrie." The verge escapement was the only one used for three and a half centuries, and even the pendulum clock presented by Huygens to the States General of Holland had it. A little later came the anchor escapement of Hooke or Clements, and then others by Graham, Le Roy, Lepaute, Mudge, and others. In his sketch, the author divides the history of the clock into three periods, the second of which opens with the work of Huygens, while the third, "the scientific period," began with the work of Edouard Phillips, who in 1861 published his essay "Mémoire sur le spiral réglant."

Marine meteorology is dealt with in the *Marine Observer* for December published by the Meteorological Office, Air Ministry; this completes Vol. I., which commenced with 1924. The publication emanates from the Marine Division; communications are contributed by the marine staff, and interesting

items are given by the voluntary marine observers, for whose benefit the work is primarily undertaken. "Wireless and Weather, an Aid to Navigation," has been made a special feature throughout the year, and the December number is of special interest to seamen, dealing with phenomena common to the Atlantic and Pacific Oceans. A quotation is given from "Physical Geography of the Sea and its Meteorology," written by Maury about sixty years ago, given apparently to show that over the open ocean there are no interfering causes as commonly exist over land. With our present knowledge of the weather, the North Atlantic with its cold Arctic current flowing southwards and the Gulf Stream flowing northwards, together with other interfering causes, it is not easy to admit that over the ocean "the agents which are at work are of a more uniform character" Synchronous weather charts are given, drawn at sea from wireless reports received, and these will prove very helpful to other observers wishing to obtain similar information It is only recently that it has been possible to draw weather charts at sea, of similar use and with somewhat equal accuracy to the synchronous charts drawn on shore at special weather bureaux A retrospect of the results given in the first volume and the interest in the work taken by seamen is said to justify the continuance of the publication Without doubt marine observers are regaining their pre-War interest in meteorology.

AT the twelfth annual meeting of the Indian Science Congress to be held at Benares under the auspices of the Benares Hindu University on January 12-17, His Highness the Maharajah of Benares will be the patron and Dr. M O Forster, Director of the Indian Institute of Science, Bangalore, will be the president. The Sections and their presidents are as follows.—*Agriculture*, R. S. Finlow, Director of Agriculture, Bengal, Dacca, *Physics and Mathematics*, Prof E. P. Metcalfe, Principal, Central College, Bangalore, *Chemistry*, Dr. J. C. Ghosh, University professor of chemistry, Dacca; *Zoology*, Dr Baini Prasad, Officiating Director, Zoological Survey of India, Calcutta; *Botany*, Prof. R S. Inamdar, University professor of botany, Benares Hindu University, *Geology*, Dr G E Pilgrim, Superintendent, Geological Survey of India, Calcutta; *Anthropology*, Prof P C. Mahalanobis, Presidency College, Calcutta, *Medical Research*, Lieut.-Col F. P Mackie, Director of the Bombay Bacteriological Laboratory, *Psychology*, Dr. N. N. Sen Gupta, professor of psychology, Calcutta University. Besides the usual sectional programme, general discussions have been arranged on the following topics. The physical and chemical aspects of valency; the true path of industrial development in India; the relation of insects to disease in man, animals and plants; the fauna and flora of Krusadai Island near Rameshwaran. Popular evening lectures will be delivered by Prof. A. J. Turner, on "Science and the Cotton Industry"; by Dr. S. N. Gore, on "Bacterial Flora of Drinking Water in India", and by Prof. P. Sampat Iyengar, on "The Growth of India." Lieut.-Col. F. P. Mackie will give a cinema demonstration on malaria and kindred subjects. A number of excursions and social functions are also being arranged in connexion with the Congress

SIR OLIVER LODGE has accepted the presidency of the Radio Society of Great Britain in succession to Dr W. H. Eccles, who has held the office for the past two years

WE much regret to record the death on December 26 of Dr G D. Liveing, F R S., president of St John's College, and formerly professor of chemistry in the University of Cambridge Dr Liveing, who reached the advanced age of ninety-seven years on December 21 last, was the victim of an accident some two months ago and he never recovered His early work was chiefly in the domain of spectroscopy, and he was awarded the Davy Medal of the Royal Society for his contributions to that subject so long ago as 1901

PROF E. GOURSAT, of the faculty of science of the University of Paris, and Prof L Bianchi, professor of analytical geometry in the University of Pisa, have been elected associates of the section of mathematical and physical science of the Académie royale de Belgique (Classe des Sciences), and the Lamarck Prize (Zoology) has been awarded to Prof E Chatton, professor of general biology in the University of Strasbourg

THE University of Sydney commemorated on October 23 last the centenary of the publication of Sadi Carnot's "Réflexions sur la puissance motrice du feu" Representatives of almost all the scientific and educational institutions of Australia were present at the commemoration Lectures on the bearing of Carnot's work on modern science and industry were delivered by Sir Henry Barraclough and Prof. O. U Vonwiller, and exhibitions and demonstrations of modern oil, gas, and steam engines and refrigerating machinery were given in the Engineering Laboratory of the University

IN conjunction with the Meteorological Office, Mr S Morris Bower, Langley Terrace, Huddersfield, purposes to continue, during this season (January 1-March 31), the annual record of winter thunderstorms in Great Britain hitherto made by Mr. C J P. Cave, of Petersfield (see NATURE, December 30, 1922, p 877). Reports from all parts of the country are desired, especially from Scotland, Ireland and the North of England.

THE last meeting of the Illuminating Engineering Society was held at the E L M A. Lighting Service Bureau—an interesting departure with the view of bringing practice and theory into line Visitors, including representatives of gas lighting interests, had an opportunity of witnessing demonstrations of the latest types of lighting units and examining critically methods of impressing the benefits of good lighting on the public. Some of the appliances shown illustrated aptly the application of scientific principles in the lighting industry, and there was one device, a new form of camera shown by Dr Rosenthal, that excited considerable interest. This compact form of

camera is expressly designed for taking photographs by artificial light and is provided with an exceptionally large aperture. It was stated that an exposure of two seconds was sufficient with illuminations not less than 5 foot-candles—a speed that would easily enable photographs of artificial lighting installations to be taken with figures in the foreground In the case of factories, this is likely to be a considerable advantage

KING EDWARD'S HOSPITAL FUND for London has arranged a series of evening popular science lectures, by distinguished scientific workers, during January, February, and March. The lectures are to be given at the Imperial College of Science and Technology, King's College, Birkbeck College, and various polytechnics spread over London, and the proceeds go to the Hospital Fund Sufficient guarantee of the interest of the lectures is given by the list of lecturers: Sir Sidney Harmer, Sir Richard Paget, Bart, Sir Robert Robertson, Profs Winifred Cullis, A O Rankine, S. Chapman, E W MacBride, C S Myers, G. Elliot Smith, E N da C Andrade, J S S Brame, F J Cheshire, and Leonard Hill, Mr. W E Garner, Mr. C R Darling, Capt P P Eckersley, and Major R. W Mayo. Tickets can be obtained from the secretary of the institution at which a lecture is to be held, or from the secretary of King Edward's Hospital Fund for London, 7 Walbrook, E C.4 (price 1s); serial tickets, available for any number of the lectures (price 4s), can also be obtained at the latter address. Admission is by ticket or payment at the entrance

"THE Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company" is in future to be issued annually because of the increasing number of the publications that have to be dealt with The seventh volume that has just been received gives, in a slightly abridged form, the 22 papers that were printed during 1923 in various English, American, and French scientific journals. The full reference is given to the original source in each case, so that any one specially interested in any particular paper may refer to the full communication. The abridgments are classified under the headings of physical optics, photographic optics, inorganic, organic, physical and colloid, and analytical chemistry, photographic theory, and practical photography. They carry forward the work for which this Laboratory has become so well known.

THE Cambridge University Press announces for early publication "Scientific Papers," by the late S. B McLaren, dealing mainly with electrodynamics and natural radiation. The work has been prepared for publication by Profs. H. H Hassé, T H Havelock, J W. Nicholson, and Sir Joseph Larmor The same firm also announces "Plant Life on East Anglian Heaths," by Dr E. P. Farrow. The volume will contain an account of some observations, problems and experimental work relating to the ecology of the vegetation of the East Anglican heath district known as the "Breck Country"

"THE Scientists' Reference Book and Diary," published by Messrs. Jas. Woolley, Sons and Co., Ltd, 76 Deansgate, Manchester, is as attractive and handy a book as any scientific worker could desire. It includes useful information, constants, and conversion tables, relating to many branches of science, lists of universities and scientific institutions, mathematical tables, and much other matter, in addition to a diary for 1925 and several detachable pages of squared paper The price of the publication is 3s. 6d., and we can confidently recommend this twenty-seventh issue to all science teachers and students.

Our Astronomical Column.

A NEW COMET?—A telegram from the Copenhagen Astronomical Bureau announces the discovery of a nebulous object by Prof Wolf at Königstuhl Observatory on Dec $23^d\ 8^h\ 15{\cdot}7^m$ G.M.T Its R.A. was $4^h\ 8^m\ 19\ 47^s$, N. Decl $24°\ 31'\ 36''$ (referred to equinox of 1924 0), daily motion -28^{sec}, south 14′, magnitude 16·0

Two plates were exposed by Mr G Merton with the 30-inch reflector at Greenwich on Dec. 26, but up to the present, the object has not been located upon them It is clearly beyond the reach of ordinary instruments

VARIATION OF LATITUDE.—The *Japanese Journal of Astronomy and Geophysics*, Vol 2, No. 3, contains a discussion by H Kimura of the results obtained at the international latitude stations, Mizusawa, Carloforte, and Ukiah, in the last two years. The star-places and proper motions have been rediscussed; the amplitude of the combined wave during the period discussed is about 0 2″, that of the ε or Kimura term about 0 05″.

The author concludes that there is a 19-year term in the variation, and that the following sub-multiples of this period have sensible coefficients: $\frac{1}{18}$, $\frac{1}{19}$, $\frac{1}{14}$, $\frac{1}{13}$, $\frac{1}{18}$, $\frac{1}{18}$, $\frac{1}{11}$. The second and fifth have the largest coefficients. These are the well-known annual and 14-month terms. He further believes that terms found in earthquake analysis appear also in the polar motion, indicating a close connexion between the phenomena

CONVECTION CURRENTS IN THE ATMOSPHERES OF THE SUN AND STARS.—The Proceedings of the National Academy of Science, Washington, for September 1924 contains a paper by C. E. St. John and H. D. Babcock on this subject. They confirm previous conclusions that the pressure is a small fraction of an atmosphere, being 10^{-1} atm. at the photospheric level, 10^{-4} at 5000 km., and 10^{-18} at 14,000 km. The daily rotations at these heights are 13·84°, 14·44°, 15·4°, and the linear velocities 1·97, 2 06, 2 18 km./sec. The convection currents are downward 0·5 km./sec. at 14,000 km., downward 0 3 km./sec. at 1500 km., and upward 0·3 km./sec. near the photosphere. The authors have made a similar examination of the spectra of Sirius, Procyon, and Arcturus; they conclude that the difference of convection speed for high level minus low level increases with temperature, being 1·20 km./sec. for Sirius, type A, 0·67 for Procyon, type F, and 0·34 for Arcturus, type K. It may well amount to 4 km./sec. for type B, which would explain the well-known "K" term for these stars. The pressures in the atmospheres of Sirius, Procyon, and Arcturus are concluded to be of the same order as that in the sun; the largest value found is 0·4 atm.

Research Items.

HEREDITY IN FINGER PRINTS.—Attention was first directed to the indications of heredity in papillary ridges by Galton, upon whose investigations our knowledge of finger prints is based. His evidence on this point consisted of a statistical treatment of 150 fraternal couplets, an investigation of 17 sets of twins, and a comparison of children with their parents when both parents were like patterned. Galton himself pointed out that the number of his cases was too few to justify quantitative conclusions The question has been investigated further by later workers, of whom the most recent is Mlle. Kristine Bonnevie, of the University of Kristiania, who has had the finger prints of the Court of Justice of Kristiania placed at her disposal. This material covers 24,578 Norwegian criminals The result of an examination of these data is published in the *Journal of Genetics*, vol 15, pt 1. The statistical investigation follows Galton's results very closely, showing a percentage for all fingers :—whorls 25·65, radial loops 5·81, ulnar loops 61·14, and arches 7·4, the distribution being characteristic for all fingers. A comparison with material from other races showed the total numerical occurrence of each pattern type to be characteristic of each race investigated, while the distribution of each type upon the various fingers showed in all races the same characteristics as in the Norwegian material Among other conclusions of considerable importance, a number derived from data furnished by related individuals clearly suggest that finger patterns are hereditary Further, there is seen to be a causal connexion between the appearance of the patterns and the shape of each finger-ball

THE CULTURE OF THE NEWARS —The Newars form the most numerous group of the inhabitants of the Valley of Nepal proper, and afford an interesting example of the effect of a fusion of cultures—a point of view from which they have been studied by Mr. K. P Chattopadhyay in a communication in the Journal of the Asiatic Society of Bengal, N.S vol. xix pt. 10 They are divided into the Bauddhamārgis who worship Buddha, and the Sivamārgis who worship Siva, but since their conquest by the Gurkhas, who entered Nepal in 1768, the former have, under the encouragement of their conquerors, lost ground to the latter, who may be termed Hindus, and have an organisation similar to that of the Hindus of the plains, though of a simpler character The Bauddhamārgis are divided into three grades A peculiarity of the castes is that most have a religious duty to perform at the festivals, and are as much religious organisations as social Among the Hindu Newars, the only definite secular occupation followed by any caste except fighting, trade, and cultivation, is that of cowherds. All other occupations are followed by pure and mixed Bauddhas. It is clear that the employment of cattle was not known to the Newars in ancient times, and even now is comparatively rare. Before the knowledge of cattle was introduced to Nepal, a culture characterised by knowledge of metal, wood and stone working, as well as hoe cultivation of a peculiar type, existed, and must have come from elsewhere, being imposed on a country inhabited by rude and wild tribes. An analysis of religion, social organisation, and arts and crafts indicates that this early culture came from India, and not Tibet as has been suggested. This was followed by a later Brahmanic conquest or incursion with a culture not strikingly superior to that of Nepal, into which it was assimilated. It differed in type from that Brahmanic civilisation which affected the Gurkhas.

BRITISH FOSSIL ELEPHANTS.—In *La Nature* for November 15 (No. 2641), Dr. Georges Pontier gives an account of his researches on the British fossil elephants. He figures selected specimens attributed to *Elephas planifrons*, *E. meridionalis*, *E antiquus*, *E. priscus*, *E. trogomtherii* and two forms of *E primigenius* In a table at the end he sums up his views of the evolution of the group as exemplified by the British forms, and in these views he follows very closely those of Depèret and Mayet, whose paper published in *La Nature* for August 25, 1923 (No. 2577) has already been noticed in these columns (NATURE, September 15, 1923, p 405). While the view, which we owe to Depèret and Mayet, that the various species of elephants form separate lines, with little or no connexion with one another; that, for example, *E planifrons* gave rise to *E. meridionalis* and its mutations only, that *E antiquus* is separate from it and so on, is a view which is attractive and easy of comprehension, it is nevertheless not entirely borne out by a closer survey of all the material in the numerous large collections in Great Britain It takes no account of the many apparent intergradations of the pattern and other characters of the molar teeth which have led many other authors to the different conclusion that there is much interrelationship It places also too great a reliance on the supposed correctness of the sequence in time of the described mutations, some of which can be shown to occur in England in the same beds instead of appearing in subsequent strata The paper, however, forms an interesting and valuable contribution to a very perplexing problem.

NORTH AMERICAN MAMMALS —Mr. G S. Miller has a two-fold object in drawing up his List of North American Recent Mammals, 1923 (Bull U.S Nat. Mus., No 128). to direct attention to the richness of the United States National Museum collections, and to furnish a summary of the systematic results of the study of North American mammals to the end of the year 1923 The stupendous nature of Mr Miller's task may be gauged from the fact that the United States National Museum collections contain 106,000 skins, three-quarters of which have been brought together by the United States Biological Survey, to the work of which Mr Miller pays full tribute. The completeness of the collections may be judged when it is remembered that out of 2554 forms represented in North America, only 171, or less than 7 per cent, are absent from the national collections, while the number of types at the disposal of the author was 1435 Mr Miller has furnished under each species or sub-species a reference to the first publication of the name, or to the publication in which it was first admitted to the North American list, and he has correlated his nomenclature with previously published lists. Under each form the type locality is given with great exactitude, and the known range briefly indicated. Mr. Miller's paper will be an invaluable work of reference for all engaged in the study of mammalogy.

A PROBLEMATICAL ORGAN IN THE LAMPREY —Mr. G. R. de Beer (*Jour. Anat.*, vol lix pt. 1, pp 97-107, October 1924) has investigated the problematical organ in the olfactory capsule of Petromyzon first made known by W. B. Scott, and the subject of much speculation by subsequent workers. The organ is vesicular, the vesicles being closed, lined with ciliated glandular cells, containing fluid, and immersed in blood sinuses innervated by branches of the olfactory nerve. The diverticula from which the vesicles

arise in the larva contain secreted (excreted) matter, and the fluid in the adult vesicles is evacuated through the blood There is not sufficient evidence to indicate the homologies of the organ, but the author thinks the evidence not strong enough to warrant the suggestion that it is the homologue of Jacobsen's organ He inclines to the view that it is a gland, possibly endocrinal in nature, the secretion being carried away in the blood sinuses with which it is surrounded Experimental tests with extracts from the organ give negative pituitary reactions No similar organ was found in the allied genera Myxine or Bdellostoma

A DEVONIAN PLANT WITH ALGAL ORGANISATION AND TETRADS OF RESISTANT SPORES —This interesting conjunction of characters seems to be present in *Sporocarpon furcatum*, a fossil plant from the black shale of the Devonian strata of Ohio, first described by Sir William Dawson, who saw in these saccate, flattened pellicles, the compressed remains of the sporocarps of some unknown plant The late Dr R Kidston and Prof W H Lang now report, in the Transaction of the Roy Soc of Edinburgh, vol 53, pp 597-601, the finding of tetrads of spores in specimens of this plant The authors conclude that the mode of occurrence, general appearance, and structure of the specimens strongly suggest that they are the more persistent tips of some thallod Alga of the period The disposition of these spore tetrads might be paralleled among living Rhodophyceae, but the resistant nature of the thick wall of the spores and the presence of surface marking corresponding to the place of contact of the spores then become features of extraordinary interest, as they are not found in any known Alga

THE IMMUNITY OF APPLE STOCKS FROM WOOLLY APHIS —In the *Bulletin of Entomological Research* for November 1924 (vol xv pp 157-170), Mr L N Staniland attempts to explain this immunity in certain apple stocks It is well known that the woolly aphis induces gall formation on its host plant, and Mr. Staniland remarks that the cambium is affected, almost certainly by the salivary secretion of the insect, in such a way that each of its cells divides more rapidly than normally, thus producing the gall tissue Later, the medullary rays are affected and also contribute to gall formation The occurrence of sclerenchyma in the host-plant plays an important part in relation to the susceptibility of different varieties of apple to woolly aphis attack The chances of the stylets of the aphid reaching a point near to the cambium bear a definite relation to the degree of development of the prohibiting factor, sclerenchyma The latter tissue, to a large extent, affords a barrier to the passage of the stylets There is also a definite relation between the possibilities of penetration and the number of thin-walled "penetration areas" between the masses of sclerenchyma When the masses of the latter are large, and the softer penetration areas between them are reduced to a minimum, the chances of successful attack are enormously reduced Among the varieties of apple studied it was found that a series arranged according to degree of susceptibility of attack largely corresponds with one arranged in order of the completeness of the development of the sclerenchyma ring

GEOLOGY OF THE GOBI —The geological results of the Asiatic Expeditions of the American Museum of Natural History include a detailed study of the basin structures of Mongolia, a first instalment of which is presented by C. P Berkey and F. K. Morris in the Bull Am Mus. Nat. Hist., vol li., 1924, pp 103-127. Between the Arctic and the Pacific divides lies the Gobi Basin, a down-warped plateau bounded by rims that stand some 3000 feet above its average level. Within it are many minor basins that the authors distinguish by the term *talas* (Mongol for "open steppelands"). Each of these in turn contains still smaller basins which are the *gobis* proper of the Mongols The basement rocks make up a deformed complex that probably corresponds on the whole to the Archæan of other lands, and in particular to the T'ai Shan complex of China. Above these there are probable representatives of the Middle and Upper pre-Cambrian, and all are cut by an immense bathylith Next come infolded remnants of Carboniferous and Permian marine sediments, and a more extensive series of continental clastics that seem to be of Lower Jurassic age All these older formations were strongly folded and worn down to a mature peneplain before the nearly horizontal basin sediments were deposited. These belong to the Cretaceous and Tertiary, and represent a continuation of continental conditions that have persisted right down to the present day Two types of Gobi basins are recognised: one characterised by a faulted margin on the south, where the basins abut against the fault-block ranges of the Eastern Altai, and the other by simple down-warping in the less disturbed areas The faulted basins contain lavas and a much greater thickness of sediments than the warped basins, but in both types sedimentation was intermittent, and in any one basin long intervals are unrepresented by deposits. The Miocene, for example, is almost completely absent from vast areas of Asia On the whole, then, the Angara-Gobia continent seems to have been stable for long periods, and to have suffered regional denudation ever since the (?) Jurassic folding Complementary sedimentation within its own borders is registered only where gentle warping and marginal faulting provided temporary collecting basins

AUSTRALIAN CHINA CLAYS —Australia has large deposits of china clay, and a report has been prepared on their different qualities ("Australian Clays in the Manufacture of White Pottery Wares," by R. C Callister, Bull 27, Institute of Science and Industry, Commonwealth of Australia, Melbourne, 1924) The results are presumably of a preliminary character. Most of the china clay employed in the work was from Lal Lal, and it is said that in this locality "very large quantities were available of a very uniform composition, later it was proved that this uniformity was further increased" when the material from the top was not mixed with that from below, but analyses justifying these statements are not included The ultimate composition is not far removed from that of some of the English china clays The statement that the osmose process of purification has been condemned in America, may convey a wrong impression. Very elaborate and expensive trials on the process have also been made by the British Refractories Research Association, and a few extracts from the report were indicated by Mr. S R Hind in the *Gas Journal* (Supplement, July 9, 1924). The net result showed that the expense did not justify the results obtained by this mode of purifying fireclays. Several countries have deposits of good china clay near at hand, and yet many manufacturers prefer to import the Cornish clays, *e g.* Germany, the United States, etc. Manufacturers have stated that they prefer Cornish clays because (i.) their uniformity can be depended upon from year to year; and (ii.) with other clays there are small losses in manufacture which are a constant and irritating dead-charge on the output. It is to be hoped that the Australian china clays will prove an exception.

AUSTRIAN METEOROLOGY.—In the year-book for 1920 of the Zentralanstalt für Meteorologie und Geodynamik in Vienna, Dr. F. M. Exner directs attention to the number and distribution of meteorological observatories in Austria. There are now 86 observatories, of which 16 are of the first class. The year-book gives the full daily observations at Feldkirch, Salzburg, Sonnblick, Vienna, Graz and Obir, and the monthly and year means for all stations. Further tables give additional data for Vienna from self-registering instruments, while the final section gives the records of air movements derived from pilot balloons at Vienna in 1919 and 1920, to which are added some data from the Hochobir observatory in Carinthia at an elevation of 6700 feet.

FREQUENCY OF HEAVY RAIN IN INDIA.—Memoirs of the Indian Meteorological Department, vol. xxiii. pt. 8, gives much valuable data by Sir Gilbert T. Walker, who was until recently Director-General of Observatories. The object of the discussion is to supply engineering and other projects dependent upon rainfall with trustworthy information regarding both the frequency of heavy rain over various districts of India and the maximum amount of rain to be expected within definite short periods. The observations are for all rain-gauge stations maintained during the period of 30 years from 1891 to 1920, using data only where records are available for at least 10 years, and the number of years is stated. The falls are given for 24 hours, ending at 8 A.M., for the amounts of 3 to 4 inches, 4 to 5, and for each inch to 15 inches, while information of falls exceeding 15 inches in 24 hours is given as footnotes to the ordinary tables. To test the accuracy of the 30 years' limit, frequency tables have been compiled for 8 stations using all available data, the Madras observations cover a period of 85 years and Bombay 76, both of which show the 30 years' results to be quite satisfactory. The tables are grouped for the several divisions. At Cherrapunji, where there are two rainfall stations, the records extend over 30 years; these show a fall of 39 to 40 inches in the 24 hours, and 5 other falls between 30 and 35 inches, while there are in addition 25 falls between 20 and 30 inches in the 24 hours. There are more than ten other stations with a rainfall of upwards of 20 inches in the 24 hours. Rainfall frequencies at five stations in the south of the Bombay Presidency are given in an appendix; these are said to bear out Blanford's statement "that the greatest quantity of rain is yielded by falls not differing very much from those of average measurement." Reference is made to Part 7 of the same volume, which gives the monthly and annual rainfall amounts for all Indian stations to the end of 1920. (See NATURE, June 7, 1924, p. 836.)

MEASUREMENT OF RADIO FREQUENCY.—A paper (No. 489) of more than ordinary interest on the measurement of radio frequency by Grace Hazen and Frieda Kenyon has been published by the Bureau of Standards at Washington. A direct comparison is made between the accurately known frequency of a tuning fork and a high radio frequency. Two intermediate radio frequency generating sets are employed and the adjustments are made by noticing the Lissajous figures produced in a cathode ray oscillograph. The tuning fork had a frequency of 1024·2 periods per second and was driven by a five-watt electron tube generating set. The intermediate generating sets each used a 250-watt electron tube. The oscillograph had a tube of the cold cathode type and required about 20,000 volts to operate it. The Lissajous figures were formed on the fluorescent screen by applying the two alternating magnetic fields at right angles to one another. The procedure adopted was to adjust the frequency of the first intermediate set to be a known multiple of the audio frequency. A range from 1·5 to 22 times the audio frequency was thus obtained. The second intermediate set was then adjusted to the first intermediate set in a similar way. Finally a point on the scale of the high frequency meter was found. The range of the wave meter standardised in this way extends from 3·5 to 5000 kilocycles per second. Photographs of the figures obtained and the apparatus used are given in the paper. The method seems to have been first used by L. M. Hull in 1919. The limitations of the accuracy attainable appear to be entirely in the audio frequency source used as the basis of the measurement and in calibrating and reading the wave meter.

THE ELECTRICAL CHARGE OF THE EARTH.—In a paper in the *Annalen der Physik* for October, Dr. C. Ramsauer directs attention to the fact that, though the surface density σ can be deduced from the potential gradient in the atmosphere by means of the formula $2\pi\sigma = -dV/dh$, a direct measurement requires a definite reference point, which can now be supplied by the state of an electrically neutral atom, containing an equal number of electrons and of protons. This is the state in the interior of every conductor, independently of the distribution of electricity on its surface, and an experiment is described in which an insulated plate A, parallel to and in the plane of the earth's surface, can be covered with a conducting cover B connected to the earth, so that A, which was originally part of the earth's surface, is now in the interior of the earth. A is connected to earth through a circuit containing a galvanometer and a key. The key is pressed down with B removed, the key is raised, B is placed over A, the key is pressed down and the charge on A discharged through the galvanometer. Another current can be produced when the cover is removed and A becomes charged again. It is possible to use an electrometer instead of a galvanometer, if the capacity of the condenser A – B is known. In this way, the excess of electrons for a definite area of the earth's surface is determined; the highest value observed was about 1×10^{10} electrons or 15×10^{-10} coulombs per square metre, on one occasion, during a light shower, the density fell from 14×10^{-10} coulombs per sq. m. to zero in a few minutes. Such variations are due to space charges in the atmosphere, and possibly to the charges of the heavenly bodies.

ZIRCONIUM AND HAFNIUM OXIDES.—G. Hevesy and V. Berglund have determined the densities of zirconium and hafnium oxides by the pyknometer method (J. Chem. Soc., November). X-ray examination showed that the latter oxide contained less than 0·5 per cent. of the former, both oxides were prepared from the normal sulphate and were carefully purified. The average densities obtained were (20°). ZrO_2 5·73, HfO_2 9·67; hence the percentage of hafnium oxide in a mixture of the two oxides is given by the formula $(d - 5·73)/0·0394$, where d is the density of the oxide mixture at 20°. This formula should only be used when both oxides are prepared by exactly the same method.

ERRATUM.—In a note on Mr. J. B. Kramer's paper entitled "An Electronic Battery," in the issue of December 13, p. 873, it was stated that the terminal connected to the carbon is negative, this is incorrect—the terminal connected to the zinc is negative, and that connected to the carbon positive.

Cloud Forms.

THE United States Weather Bureau at Washington has issued a publication [1] which would seem to be intended as a guide to cloud forms for meteorological observers It consists of a short introduction, two diagrams of cloud height frequencies, a page devoted to definitions of cloud forms, taken from the International Cloud Atlas, and 32 photographs of different forms of cloud. The memoir gives in convenient form information which will be useful to meteorological observers, and if any criticism may be made, it is that a few of the photographs are not quite typical and some are not clear

All modern cloud classification is based on the International Cloud Atlas The classification adopted there is based on appearance It is also recognised that form has been found to be largely dependent on height, and American observers argue that "it is therefore possible to gain information concerning the direction and velocity of the wind aloft by assigning the cloud to the height of most frequent occurrence, even though its exact height at the particular time is not known" This method has been widely used, but it has always seemed to the writer to be a procedure of very doubtful validity, especially when applied, as it frequently has been, to cirrus, for although, as we learn from the Weather Bureau Memoir, "the height of maximum frequency both summer and winter was between 8000 and 8400 metres," out of 227 measurements, yet there was a secondary maximum some 2000 metres higher "Seven-tenths of all cirrus observed were found between 7600 and 11,200 metres," which is a fairly wide range, while cirrus has apparently been observed at Blue Hill, Mass., so low as 2400 metres and so high as 15,000 metres

The method of assuming cloud heights and deducing the wind velocity at the cloud level by observing the drift is therefore liable to grave errors; the one theodolite method of observing pilot balloons has been much criticised on the same grounds, but on days when convection currents are not very active, it is not so liable to error as the cloud method One can never be certain without cloud height measurements that one is dealing with a cloud at an average height.

The consideration of the maximum height of cirrus brings to mind the so-called "night shining clouds" observed in the last two decades of the nineteenth century, supposed to be associated with the eruption of Krakatoa They had all the appearance of cirro cumulus, but their height was about 50 kilometres. The highest cirrus measured by A. W. Clayden was 27½ kilometres, there is thus a region of more than 20 kilometres in which clouds have never been observed, and then a level where they have been observed on rare occasions Perhaps it is more than a coincidence that the height of the night shining clouds corresponds with the secondary or lower maximum of meteor disappearance as determined by Lindemann

The two diagrams reproduced here (Figs 1 and 2) give cloud height frequencies for the various forms of cloud, for summer and winter respectively, as observed at Blue Hill, Mass., based upon tabulations for each 400 metres, by H H Clayton These diagrams are extremely interesting, and we wish that similar diagrams could be constructed for other parts of the globe, there must be a considerable body of information which might be made available, for there are to-day more methods than formerly of determining cloud heights. The diagrams show very clearly over what a wide range of height the various cloud forms

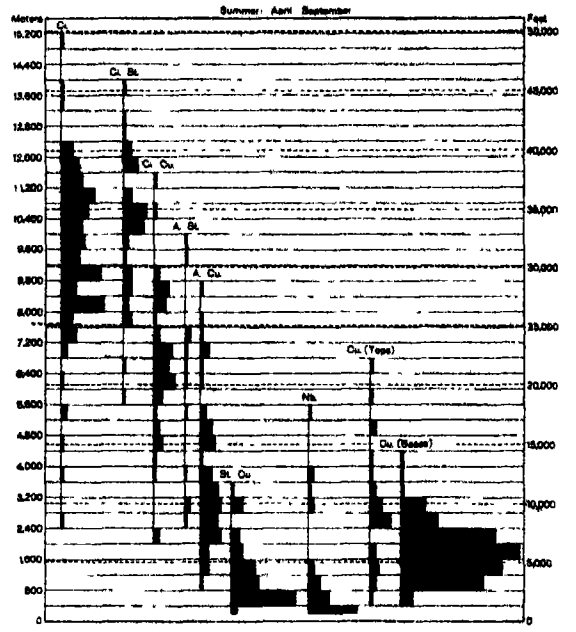


FIG. 1.—Cloud height frequencies, April to September, 1890-91 and 1896-97, Blue Hill, Mass., based upon tabulation for each 400 metres, by H. H. Clayton. Relative frequency is indicated by width of figure. From "Cloud Forms"

extend, alto cumulus overlaps cirro cumulus, and strato cumulus overlaps alto cumulus, and one is tempted to wonder whether there is any essential difference between the three forms, since neither in

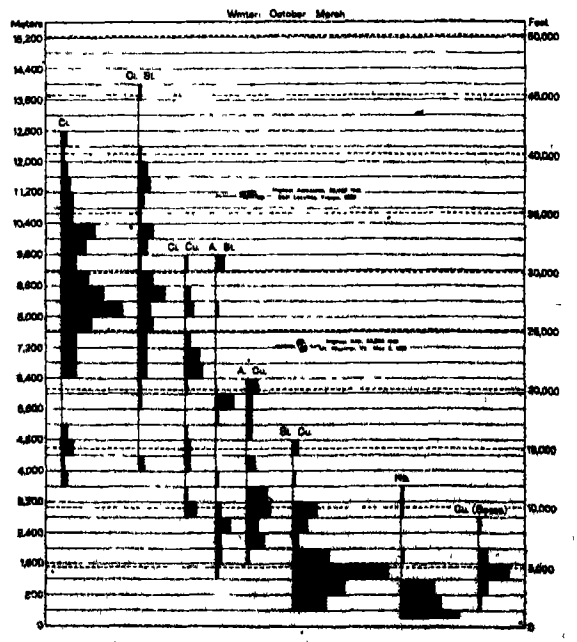


FIG. 2.—Cloud height frequencies, October to March, 1890-91 and 1896-97, Blue Hill, Mass., based upon tabulation for each 400 metres, by H. H. Clayton. Relative frequency is indicated by width of figure. From "Cloud Forms."

[1] U.S. Department of Agriculture, Weather Bureau. "Cloud Forms according to the International System of Classification." Prepared by the Weather Bureau Cloud Committee Benjamin C. Kadel, Harry C. Frankenfield, and Franklin G. Tingley. Pp. 22 (Washington: Government Printing Office, n.d.) n.p.

appearance nor in height is there any line of demarcation. This is indeed recognised, for in one of the photographs, illustrating the Weather Bureau publication, of strato cumulus or alto cumulus, a note is added that "these same clouds would be called strato cumulus by an observer nearer to them and alto cumulus by an observer farther from them (as at sea level)." The heights given for nimbus are curious; the maximum frequency is quite low, 400 metres for both summer and winter, but there are occasional observations at higher levels, one in summer so high as 5000 metres.

The photographs which constitute the bulk of the Weather Bureau Memoir are interesting; and some, such as the undulated alto stratus seen from above at Mount Wilson (Plate 11), and the same form of cloud seen from below at Washington (Plate 13), are very beautiful. There is one remark to which exception might be taken; it occurs as a note under a fine photograph, by Sir David Wilson-Barker, of small alto cumulus, and runs. "Even if there are no shadows the presence of coronas or iridescent colours near the sun or moon distinguish such small alto cumulus from cirro cumulus." In the present writer's experience, iridescence and coronæ are quite common in clouds which would be classified as cirro cumulus.

The Locust Problem and its International Solution.[1]

By Dr. A. D Imms.

IT is a matter of common knowledge that the damage occasioned by locust invasions is frequently extremely serious. Thus, in the year 1874, the destruction brought about by these insects in the Rocky Mountains amounted to approximately forty million dollars In 1908 an estimated damage of one million sterling was caused by locusts to crops in the Transvaal, while the cotton crop in Egypt has often suffered severely. The intensity of an attack, and some idea of the damage done, may be gauged from the number of locusts often found within a comparatively small area. For example, in Southern France in 1920, between twelve and thirty million locusts were destroyed daily, while twenty tons of eggs were collected in a single month in the Argentine in March 1915. Since the year 1914 the countries affected by locusts include the greater part of Africa, certain parts of Spain, France, Italy, Asia Minor, Turkestan, etc The regions more especially affected lie between 20° and 40° latitude north and 15° and 45° latitude south, the equator being comparatively immune. In order to deal with these outbreaks some international organisation appears necessary, and it is to be hoped that the League of Nations will lend its authority to assist in arriving at a concerted plan of action. The need for international action is obvious when it is remembered that locust swarms can travel 18 to 300 miles in a single day, thus easily migrating from one country into another

Very large amounts of money are spent yearly by some countries on preventive measures The danger to public health caused by locust invasion is far smaller than formerly, and the last severe famine due to locust devastation was in 1866. In that year about 200,000 natives perished in North Africa The obstruction and poisoning of wells and other water supplies, however, may still entail very serious consequences

No really adequate biological studies of locusts are available, and knowledge has scarcely yet progressed beyond empirical methods. Much that has been written on the migration and breeding of these insects is sufficiently untrustworthy to demand renewed investigation. Important work, however, has been done by Uvarov, J. C Faure and Hernandez. Among the results achieved, the most important is the demonstration that certain species of locusts have two distinct phases in their development. the migrating or gregarious phase and the solitary or individual phase. Uvarov has devoted attention to the problem of migrations. These are not the result, as commonly supposed, of the necessity of finding fresh food. Locust swarms frequently leave fertile lands for others which are far less so. The factors governing these migrations need renewed study, but they appear to be governed by variations of temperature rather than by the availability of vegetation Important changes in the physiology of the individual locusts have also been observed during migration. Until sufficient biological data are available, emergency action will have to be continued in order to restrict migration and the resulting damage to crops It is to be hoped, however, that the problem will be solved if the States interested will provide for the biological investigation of locusts instead of being satisfied with occasional emergency measures

Methods of control are very varied, and it may be added that the utilisation of natural agents has been insufficiently explored The study of the insects' parasites demands further attention, and we are still not in a position to say whether important results may or may not be expected from this line of work Attempts at propagating bacterial or other diseases have not yet been successful Mechanical methods by means of artificial barriers are numerous, and these provide the means for arresting and destroying locusts in bulk but they are not by any means adequate. Physical methods—the use of fire—have been applied in various ways The modern French method of using the army flame-projector has been employed with great success in Algeria A single charge of 12 litres of crude oil is sufficient to destroy all locusts gathered on a surface of 500 square metres Among chemical methods, the use of poison gas has not proved successful in experiments Among insecticides, arsenate of soda appears to be the most satisfactory compound, and in Italy other methods of destruction have now been abandoned

International conventions for combating these insects first came into being in South America and South Africa. A further important step was taken at the Rome conference of 1920, when thirty-five countries signed a convention naming the International Agricultural Institute as the headquarters of an International Locust Information Bureau Unfortunately, it does not seem that much progress has been made, and the International Institute has not been in a position to publish reports from the Governments concerned except a few from Algeria, Bulgaria, French West Africa, and Hungary. Good work, however, has been done by North African countries, which have concluded a special agreement among themselves. It is to be hoped that effect will be given to the resolutions of the 1920 Convention and that the need of financing skilled biological study of locusts will be recognised. M. Vayssière outlines a scheme of the international organisation he proposes and suggests the League of Nations as being best able to give that assistance necessary to secure effective international co-operation of the kind required.

[1] "Le problème acridien et sa solution internationale." By Paul Vayssière. In *Matériaux pour l'étude des calamités*, No. 2, 1924, pp. 122-158. (Publiés par les soins de la Société de Géographie de Genève.)

Fields of Progress in Chemistry.

THE American Chemical Society has started a new venture in the form of a quarterly issue of *Chemical Reviews*. The first issue contains four articles on "Atomic Weights and Isotopes" (40 pp.), by Prof. T. W. Richards; on "The Constitution of Polysaccharides" (31 pp.), by Principal J. C. Irvine; on "The Theory of Membrane Equilibria" (18 pp.), by Prof. F. G. Donnan, and on "Organic Radicals" (51 pp.), by Prof. M. Gomberg. These four articles were prepared in connexion with the dedication of the Sterling Chemical Laboratory, and are now published as part of the first volume of *Chemical Reviews* by permission of Yale University.

Although prepared for another purpose, the articles may perhaps be regarded as a type to which later *ad hoc* contributions will tend to conform, and may therefore be used as the basis for an answer to the obvious question as to whether a new publication of this kind is likely to be of permanent usefulness. In our opinion, the answer is in the affirmative. Twenty years ago, in 1904, the Chemical Society of London began a series of Annual Reports on the Progress of Chemistry in order "to present an epitome of the principal steps in advance which have been accomplished in the preceding year", and more recently the Society of Chemical Industry has supplemented this work by a series of Annual Reports on the Progress of Applied Chemistry. These annual reports have established themselves as an indispensable supplement and guide to the contents of the Abstracts of the preceding year. Their most obvious limitations are found in two directions. The first is a tendency to "scrappiness," which must always result from the cutting up of a continuous series of experiments into yearly "progress reports." The second is the risk that the personal interests of the reporter in a particular branch of chemistry may lead to the over-emphasis of progress in certain directions, and the neglect of important work in others.

These limitations have been minimised by changing the reporters after a period of perhaps three years, and by encouraging them to trace in some detail the earlier stages of researches in which important progress has been made during the year; but it is clear that the new series of *Chemical Reviews* will have the great advantages that the articles will deal with a small number only of live topics and that the summaries will be authoritative statements by the worker himself, instead of by a reporter. For the general student, who wishes to secure an introduction to current literature, it may very well prove of even greater value than the Annual Reports, and, judging by the earliest samples, they have the merit of being eminently readable, so that it is a pleasure rather than a duty to study them. On these grounds the new publication may be heartily welcomed, as providing in a systematic form the type of publicity that has hitherto only been given spasmodically in lectures and presidential addresses. The price of the publication is five dollars for each annual volume, or four dollars to members of certain cognate societies; it is also proposed, if there is sufficient demand, to issue reprints of the individual articles, so that a whole class can be supplied with copies.

The International Critical Tables.

AT the meeting of the International Union of Pure and Applied Chemistry held in London in 1919, the American delegates submitted a proposal for the international compilation of critically prepared tables of the physical properties of chemical substances and technological materials. The proposal was approved by the Union, and the American National Research Council at Washington has since undertaken the financial and editorial responsibility for the undertaking. A Board of Trustees has undertaken to raise the sum of 200,000 dollars or such part thereof as may be necessary. The editorial responsibility is invested in a Board of Editors, the editor-in-chief being Dr. E. W. Washburn, formerly professor of physical chemistry at the University of Illinois.

To ensure the international character of the Tables, corresponding editors have been appointed in the principal countries of the world. It may be added that the Tables are in no sense a commercial undertaking and the members of the boards of trustees and editors and the corresponding editors serve in an honorary capacity.

The work of critically examining the data and of compiling the various tables is being carried out by well-known chemists, physicists, engineers, etc., some three hundred in number, who have been chosen for this purpose in the various countries of the world, largely on the basis of recommendations from the corresponding editors and their advisory committees. These authorities are not being expected to assume the responsibility of searching the literature, a task which is being carried out in the main by the editorial staff at Washington, but rather to assemble, to examine critically, and to select the best value for each constant, indicating at the same time the probable uncertainty. Each portion of the Tables will be published over the name of the co-operating authority who has assumed responsibility for it, and the size of each assignment has been restricted so that the work may be carried out within a reasonable time and without becoming too great a burden for any individual (or co-operating group of individuals) to bear.

The main language employed in the Tables will be English, but the introduction, table of contents, definitions, general explanatory text, and a very complete index will be in English, French, German, and Italian.

The Tables will contain all available information of value concerning the physical properties and numerical characteristics of (*a*) pure substances, (*b*) mixtures of definite composition, (*c*) the more important classes of industrial materials, (*d*) many natural materials and products, and (*e*) selected data for certain bodies or systems, such as the earth and its main physical subdivisions, the solar and stellar systems, and certain biological organisms, including man.

The scope of the Tables is so immense, and of such an unprecedentedly comprehensive character, that special attention has had to be given to the arrangement so as to enable the Tables to be used with facility and dispatch. For pure chemical substances the data will be assembled in tables of properties, but a certain amount of latitude and duplication will be permitted in some instances, and tables of materials will be employed where it proves to be more convenient. In some cases no definite value of a constant can be put down, but only upper and lower limits. In other cases a graph may be the best means of indicating the variation of the particular property in question.

The importance of securing uniformity in the case

of fundamental constants, conversion factors, etc, has not been lost sight of, nor the importance of associating, where possible, with the data for a particular specimen or material, a statement of the exact experimental conditions, life history, etc

The Tables will be issued in a series of volumes comprising a total of about 2500 pages (10 in. × 7 in.), publication extending over about a year and a half. The progress made has been such that the first volume is now in the press and may be expected during the early months of 1925. The published price of the Tables will be from 60 to 75 dollars for the set, but the trustees are reserving the privilege of purchasing from the publishers at the rate of 35 dollars per set whatever number of sets may be required to fill all advance subscriptions received by the National Research Council of America up to a definite fixed date, probably April 1 or May 1, 1925. This price represents only the cost of printing, but the trustees and the National Research Council are anxious that all scientific men and women shall be given the opportunity of taking advantage of the lower rate. Accordingly, arrangements are being made so that (1) members of a recognised scientific, technical or engineering society, or (2) universities, research laboratories, libraries, government departments or the like, will shortly be given preferential facilities for purchasing sets at the lower figure before the expiration of the above-mentioned date. The National Research Council will deal with such applications, but all orders placed in the ordinary way through the trade will be handled by the publishers at the higher figure

The Advisory Committee for the British Empire (excluding British North America) consists of Dr G. W C. Kaye (corresponding editor), Sir Robert Robertson, Dr W Rosenhain, Prof A W. Porter, Dr. T. E. Stanton, Mr. J. E Sears (jun.), Mr. A. C G Egerton, and Mr W F Higgins as secretary. Dr. Rosenhain is also acting as special editor for metals and alloys. It is requested that any correspondence from the British Isles with reference to the Tables should be addressed to Dr Kaye, The National Physical Laboratory, Teddington, Middlesex

University and Educational Intelligence.

BELFAST.—Dr. J A Milroy has been appointed J C. White professor of bio-chemistry in the Queen's University Dr. Milroy came to Belfast in 1902 as demonstrator in physiology, and on the foundation of the University in 1909 he was appointed lecturer in bio-chemistry. The title of reader in bio-chemistry was conferred on him in 1922. He is the author of numerous articles in the *Journal of Physiology* and other scientific papers

Dr. V. D. Allison has been appointed J C White lecturer in bacteriology in the University Dr. Allison is a graduate of the University, and since 1920 has continued his studies as research student in the Institute of Pathology as a Beit Memorial Research Fellow, working under Sir Almroth Wright and Prof. A Fleming

BIRMINGHAM.—Applications are invited for the professorship of philosophy in succession to Prof. Moberly. Applications (fifteen copies of each), copies of three testimonials, etc., must reach the Secretary of the University by February 2 at latest.

LONDON.—The following doctorates have been conferred:—*D.Sc.* (*Botany*). Miss K. B. Blackburn (Bedford College), for a thesis entitled "The Cytological Aspects of the Determination of Sex in the Dioecious Forms of Lychnis"; *D Sc* (*Chemistry*): Mr Harold Hunter (East London College and Battersea Polytechnic), for a thesis entitled "The Chemical Significance of Optical Dispersion", *D Sc* (*Physics*) Mr A. H Davis, for a thesis entitled "Natural and Forced Convection of Heat in Gases and Liquids," and other papers, Mr. J. H Shaxby, for a thesis entitled "Papers on Molecular Physics," and other papers; Mr J E P. Wagstaff, for a thesis entitled "The Measurement of Short Time Intervals and its Application to (*a*) the Determination of the Velocity of Detonation of Explosives, (*b*) the Duration of Impacts of Bars mainly with rounded Ends, in elucidation of the Elastic Theory," and other papers

MANCHESTER.—Applications are invited for a lectureship in anatomy The latest date for applications is February 11. They should be sent to the Internal Registrar, from whom particulars may be obtained

OXFORD.—Applications are invited from persons possessing a thorough knowledge of entomology in its application to forestry and with experience of tropical conditions for the post of entomologist at the Imperial Forestry Institute Applications, stating age, qualifications, and salary required, and furnishing references and copies of testimonials, with a list, and if possible copies, of published writings, should be submitted not later than April 15, to the Secretary of the Institute

THE official report of the Indian Universities Conference held at Simla last May (Calcutta, Govt of India Central Publication Branch, pp 79 8*d*) gives in full the Viceroy's inaugural address, two addresses by the Minister of Education, Health and Lands, and the 49 resolutions passed by the Conference, and brief summaries of the discussions. The most important outcome of the Conference is the project for an inter-university board Steps have already been taken to bring this into being, a provisional committee having been appointed immediately after the close of the Conference to make further detailed suggestions for the consideration of the universities This it has done, and it is proposed to hold the first meeting of the board in Calcutta, if possible in February next The Conference has, moreover, recommended to the Government of India that a central advisory board for scientific research be constituted in India, comprising the heads of scientific departments of the Government and a representative of science nominated by each of the Indian universities and by the Indian Institute of Science, with power to co-opt representatives of other recognised institutes of science not affiliated to any university. It is intended that this Board should, among other things, co-ordinate scientific publications in India, utilising or combining existing organs and developing them on an all-India basis and recommending to Government cases where financial assistance would be desirable It would consider whether the publications of the Indian Museum and the Botanical Survey of India, the Memoirs of the Geological Survey of India, and the *Agricultural Journal of India*, now issued by Government, should not have on their editorial boards expert representatives of the various universities, and whether the scope of these journals should not be enlarged It would also advise the Government from time to time generally with regard to the promotion of scientific research in India. Another resolution demands the remission of customs duty on scientific apparatus and chemicals imported for the use of universities and other approved educational institutions.

Early Science at the Royal Society.

January 3, 1662/3 The president reported a letter in favour of the society to the duke of Ormonde, lord lieutenant of Ireland—"I am desired by the Royal Society in their names to entreat your grace's favour and countenance in the effectual settlement of the fractions of adventures, arrears, lands, &c., which by the act for the better execution of his majesty's gracious declaration were vested in his majesty, in trust for, and the better to enable his majesty to grant the same to them, so as his majesty being their founder might also be their chief benefactor". [signed Brouncker, P R S]—Sir William Petty who was then in Ireland, was desired to make a calculation of these fractions of adventures &c., which he accordingly did, but did not send the society the result of it, in regard that interest was past before by patent acts unto some others, as he mentions to Sir Robert Southwell, when the latter desired him, in the name of several of the most eminent members of the society, to send over to them his calculations.

January 4, 1664/5 Mr Francis Willughby being come home from his travels [mostly in Spain] and present, was desired to communicate his philosophical observations. He produced a printed cut representing Saturn and Jupiter, and what Campani had lately observed in them by means of his new glasses, wrought by a turn-tool without a mold.

1666/7. Mr Oldenburg read an extract of Mons Auzout's letter to him from Paris, mentioning a new method esteemed by him better than any hitherto practised, of taking the diameters of the planets to seconds, and of knowing the parallax of the moon by means of her diameter. Dr Wren and Mr Hooke having related to the society several ways, which they had known long before of taking the diameters of the planets to seconds, were desired briefly to describe them, that so it might be signified to the Parisian philosophers, that it was a thing not at all new among the English.

January 6, 1663/4. Mr Boyle remarked that swallows frozen up in ice, upon the thawing away of the ice had been found alive, and flying about, and that a minister had sent a certificate of this to the king from Dantzic.—Sir Robert Moray related that he had been informed by his highness the Duke of York, that there were certain little springs at Croyden, which would run together, and make a stream for a certain space, and then slide under the ground, and afterwards break out again. Dr Wilkins having acquaintance at Croyden, was desired to make a particular inquiry after this fact.

January 7, 1662/3. Mr Bruce brought in an account of windmills in Holland, which was ordered to be registered. [We may recall here the reference that was made in NATURE, of Sept. 13, to the acquisition by the Franklin Institute in 1922, of a collection of books and pamphlets on windmills, inclusive of treatises on the subject in German and Dutch, 17th and 18th centuries.]

January 8, 1661/2. Sir Robert Moray communicated letters, in French, from Mons. Frenicle to Mons. Huygens, concerning the hypothesis of Saturn.—Mr Rooke read a paper of inquiries to be made in the East-India captain's voyage to Bantam.—It was ordered that all the papers of inquiries for foreign parts be written out into one paper.

1672/3 There was produced to the society a discourse of Dr. Grew, concerning his whole design with respect to vegetables, and the means of effecting it. Part of this discourse was read, to the great satisfaction of the Society who urged the publication of it.

Societies and Academies.

LONDON.

Royal Anthropological Institute, December 9.—H. **Balfour**: The origin of the art of stencilling in the Fiji Islands. The use of stencils in the Fiji Islands, for decorating bark-cloth, does not appear to have been introduced into the group from the outside, and it was suggested that the stencil designs, which are cut in leaves almost invariably, may very probably have been suggested by leaves which have been tunnelled by insect larvæ while still in the tightly rolled up state of the budding leaf. The leaves, when they unroll in the course of their development, exhibit transverse alignments of regular perforations, which bear a striking resemblance to some of the simpler Fijian stencil designs.

PARIS.

Academy of Sciences, November 24.—L. **Lecornu**: The tetrahedral system. Lowthian Bell, in 1875, regarded the earth as possessing a symmetry analogous with that of a regular tetrahedron. This question has been examined by several geologists; the author submits it to a mathematical analysis, applying the theory given in a recent note (*Comptes rendus*, t. 179, 1924, p. 853) on the deformation of a spherical envelope.—J. and Mlle. M. **Bordet**: The bacteriolytic power of colostrum and milk. Colostrum exerts a powerful bacteriolytic action upon organisms commonly present in the atmosphere. This confirms the work of Jensen (1905) and of F. Smith and Little (1922).—W. **Kilian**: The fluvio-glacial deposits of the southern bank of the lake of Geneva and their hydrological regime (Evian, Amphion, Thonon).—Jules **Andrade**: A curious theorem of metrology and its applications to chronometry.—P. J. **Myrberg**: A generalisation of the linear equations of finite differences.—E. F. **Collingwood**: The exceptional values of integral functions of finite order.—Nikola **Obrechkoff**: The convergence of trigonometrical series.—Paul **Mentré**: The non-special complexes with multiple inflectional focus.—D. **Riabouchinsky**: Some considerations on the plane rotational movements of a liquid.—P. **Idrac**: Theoretical study of the flight of the albatross in a wind increasing with the altitude.—Charles **Nordmann** and C. **Le Morvan**: Variable stars with continuous variation and Ritz's hypothesis. de Sitter has adduced observations on double stars as evidence in favour of the constancy of the velocity of light. La Rosa has criticised these views and concludes that observation of these stars proves nothing for or against the hypothesis of a constant velocity of light. The authors have shown that the amplitude of the light variation of variable stars with continuous variation is not the same in different regions of the spectrum. This experimental fact the authors consider invalidates the extension of the ballistic hypothesis of Ritz, as given by La Rosa.—F. **Baldet**: Observations of the planet Mars with the 83 cm. telescope of the Meudon Observatory. Reproductions of six drawings of the planet are given, taken between September 5 and 28. All the observations detailed confirm those already published by Antoniadi. No trace has been found of the geometrical network of filiform "canals."—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1924. Observations were possible on 83 days during the quarter. The results are summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Rafael **de Buen**: Some observations on the course of the currents in the Straits of Gibraltar.—

P **Gaubert**. The circular polarisation of the light reflected by insects Detailed examination shows that the insect behaves as though the cuticle which surrounds it had been cut out of a single sheet of tissue capable of polarising light circularly Two hypotheses are examined, in which the presence of liquid crystals is assumed Cholesterol melts at 147° C, and as the polarisation phenomena do not completely disappear below 300° C, the presence of this substance does not afford an explanation — L **Décombe** Electrified spherical films The direct calculation of the constant of gravitation as a function of the constants of Avogadro, Faraday, Rydberg, and Planck --Ch. **Féry**. A lead accumulator incapable of being sulphated The fundamental equation governing the working of the ordinary secondary battery is assumed to be

$$2Pb + H_2SO_4 + Pb_2O_5 \rightleftarrows Pb_2SO_4 + 2PbO_2 + H_2O$$

According to this view, lead sulphate, $PbSO_4$, is not formed during a normal discharge The spontaneous discharge of an accumulator on standing is regarded as due to the combined action of oxygen and the electrolyte on the negative plate

$$2Pb + H_2SO_4 + O = Pb_2SO_4 + H_2O,$$

with a secondary reaction

$$Pb_2SO_4 + H_2SO_4 + O = 2PbSO_4 + H_2O$$

To avoid the last reaction it should be sufficient to prevent access of oxygen to the negative plate A description is given of a new form of accumulator designed to fulfil this condition This battery retained 33 per cent of its charge after standing 26 months, corresponding with a discharge of 4 per cent per month If discharged, and allowed to stand two years, it could be recharged normally -- Victor **Henri** and C **Teves** The absorption spectrum of sulphur vapour as depending on the constitution of the molecules The molecules S_8 and S_6 present a structureless continuous absorption spectrum The S_2 molecules possess an absorption spectrum formed of a very large number of bands, the structure of which is analysed in detail (*v* also NATURE, December 20, p 894) -- M **Bourgeaud** and A **Dondelinger** Researches on the affinity constant of some organic bases —D **Yovanovitch** and J. **d'Espine**. The magnetic spectrum of the high velocity β-rays of mesothorium 2 Two of the lines have velocities 0·998 and 0 986, compared with the velocity of light taken as unity.—A **Vila** The reduction of sulphuric acid to hydrogen sulphide The vapours of sulphuric acid mixed with an excess of hydrogen and passed over silica at a red heat (700° C. to 900° C) give almost theoretical yields of hydrogen sulphide — L. J. **Simon** and V. **Hasenfratz** The lactone of *l*-arabonic acid and some of its derivatives —Ch **Courtot** and A. **Dondelinger**. The α-halogen derivatives of indane —C **Kohn-Abrest** The gases in fresh, putrefied, and frozen blood. Application of the method described in a previous paper to the determination of carbon dioxide, oxygen, nitrogen, and sulphuretted hydrogen in blood It is shown that freezing blood not only arrests putrefaction, but also removes some hydrogen sulphide if this has been already produced by putrefaction.—Y **Milon**. The fauna and the age of the Waulsortian limestones of Saint-Pierre-la-Cour —G. **Mouret** The true prolongation, at Bourganeuf (Creuse), of the Argentat fault and the nature of the supposed schists and gneiss of that region —Louis **Barrabé** and Pierre **Viennot**. The discovery of an oil-bearing layer at Gabian (Hérault). This boring has been carried to a depth of 107 metres, and the present hourly yield of crude oil is between 500 and 600 litres The oil has a density of 0·846 at 15° C, contains 10 per cent. of wax and only traces of asphalte —Gabriel **Guilbert**. The case of destruction of a cyclone —Ph **Schereschewsky** and Ph **Wehrlé** Polar pseudo-fronts — H **Colin** The formation, distribution, and circulation of inulin in the stem of the Jerusalem artichoke. —J **Chaze** Attempts at pure cultures of a Saprolegnia —Marc **Bridel** The presence of very large quantities of free maltose in the fresh tubercles of *Umbilicus pendulinus* These tubercles contain large quantities of maltose as a food reserve, and it has been possible to obtain nearly 4 per cent in the crystalline state This is the first time that maltose has been directly extracted in the crystalline state from plants —R **Cerigneli** Indol in the flowers of Spanish jessamine (*Jasminum grandiflorum*) Indol is a normal constituent of the flowers of this plant. —J **Chaussin** Study of the soluble medium and the insoluble tissues in the course of the development of wheat the influence of a complete mineral manure. —Lucien **Daniel** Heredity in grafted plants --M. **Munerati** Contribution to the study of the appearance of sex in dioic plants —L. **Mercier** The action of naphthalene vapour on *Calliphora erythrocephala* Study of the microscopic lesions presented by the individuals showing malformation —L. **Leger** A new crayfish in French waters — P. **de Beauchamp** The appearance of variations under experimental conditions in rotifers of the genus Brachionus — R **Herpin** The swarming of *Perinereis Marioni* The evolutive cycle of *Platynereis Dumerilii* —Ph **Joyet-Lavergne** The cytoplasmic characters of sexuality in the Gregarinæ — W **Vernadsky** The representation of the chemical composition of living matter — Mlle Eliane **Le Breton** and Charles **Kayser** The metabolism of the purins in diabetes —Mme L. **Randoin** and H **Simonnet** Growth and maintenance of the rat submitted to an artificial diet deprived both of factor B and glucides — C **Dawydoff** The return of *Lineus lacteus* to an embryonic state under the influence of starvation — C **Lebailly** Flies play no part in the dissemination of aphthous fever

VIENNA.

Academy of Sciences, November 13 —F M **Exner** The pressure of sand-hills Attempts have been made to measure the pressure on a plane undersurface of sand masses thrown up with maximum slopes The pressure values in the middle of the base were about those of water columns of the same height, although the density of sand is 1 5 Towards the edges the pressure decreases more slowly than would correspond to the height of the sand This is because the side columns, in consequence of friction, bear part of the weight of the central columns Hyperbolas drawn between the sloping surfaces as asymptotes correspond to this pressure distribution The idea can be applied to determine the form of the compensation defect masses below sea-level in the theory of isostasy —F **Pollak** The kinetics of dissolved gases I The evaporation of carbon dioxide from watery solution into a stream of bubbles of an indifferent gas —M. **Kohn** and G **Loff** VIII. Communication on bromo-phenols Bromo- and bromo-nitro-resorcin —M **Kohn** and G **Löff** On styphnic-acid-mono-methyl-ether and a new trinitro-guaiacol —M. **Kohn** and R. **Lakner** On the action of magnesium-phenyl-bromide on bromo-ethyl-phthalamide —A **Kieslinger** Report on geological and petrographic researches in the Southern Kor Alps on the boundary of Styria and Carinthia. These include (*a*) old crystalline, Teigitsch series, etc, (*b*) diaphthorite zone, (*c*) Mahrenberger series, (*d*) Tertiary covering —J. **Kaesz** Solution of the Delian problem by compasses and ruler.—H. **Priesner** New Thysanoptera.

Official Publications Received.

Ceylon Journal of Science Section A, Botany Annals of the Royal Botanic Gardens, Peradeniya. Vol 9, Part 2, November 22 Pp 119 241. (Peradeniya. Department of Agriculture, London Dulau and Co Ltd) 8 rupees

Spolia Zeylanica Issued from the Colombo Museum, Ceylon. Edited by Dr Joseph Pearson Vol 12, Parts 47 and 48. Pp 385-408 (Colombo)

Report of the Botanical Survey of India for 1923-24 Pp 18 (Calcutta Government Printing Office)

Appendix No 2 to the Annual Report of the Chief of the Bureau of Navigation, 1924 Annual Report of the Naval Observatory for the Fiscal Year 1924 Pp 25 (Washington Government Printing Office)

The Indian Forest Records Vol 10, Part 5 Analysis of the Tanning Properties of certain Burma *Lagerstroemias* By E Pasupati, reported by J A Pilgrim Pp 28 7 annas Vol 10, Part 8 The Constituents of some Indian Essential Oils Part 18 The Essential Oil from a new Species of *Andropogon* occurring in the Etswah District, U P By John Lionel Simonsen Pp 13 3 annas Vol 10, Part 10 The Mangroves of South Tenasserim, being an Account of an Investigation of various Products of the Littoral Forests of Southern Burma By J A Pilgrim Pp iii+73 15 annas. (Delhi Government Central Press)

Commercial Intelligence Department, India Agricultural Statistics, 1921-22 Vol 2 Area, Classification of Area, Area under Irrigation, Area under Crops, Live Stock, and Land Revenue Assessment, in certain Indian States Pp ii+v+83 (Calcutta Government of India Central Publication Branch) 15 annas, 1s 6d

Transactions of the Royal Scottish Arboricultural Society Vol 38, Part 2, October Pp 69-155+27-36 (Edinburgh) 3s

Bulletin of the American Museum of Natural History Vol 50, Art. 6 Insect Sounds By Frank E Lutz Pp 333-372 (New York)

The Physical Society of London Proceedings Vol 37, Part 1, December 15 Pp 74 (London Fleetway Press, Ltd) 6s net.

Leeds University. Twentieth Report, 1923-24 Pp 104 (Leeds)

Diary of Societies.

SATURDAY, JANUARY 3

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 9.30 A.M.—S. W. Rider and Capt. T. K. M. Booth: Discussion on School Geography.—Miss A. Hicks and others: Discussion on The Beginnings of Geography.—J. A. Mortlock, Miss J. A. Hardy, and others: Discussion on The Teaching of Climate.—Miss L. C. Read, C. C. Carter, and others: Discussion on Home Geography.—Mr. Cattell-Jones, Rev. J. I. Miller, and others: Discussion on School Geography Clubs and Journeys.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (IV.): The Habits of the Dragonfly.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—Dr. W. Martin: Gilbert White as Antiquary.

MONDAY, JANUARY 5

MATHEMATICAL ASSOCIATION (at London Day Training College), at 10.20 A.M.—Prof. J. E. A. Steggall: The Neglect of Arithmetic in Schools.—A. Buxton: An Application of the Bessel Functions to a Problem in Optical Resolution: Discussion on Tangency and Limits in Geometry.

EUGENICS EDUCATION SOCIETY (at University College), at 11.—National League of Health, Maternity, and Child Welfare.—Dr. J. A. Hadfield: Mental Health of the School Child.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Brig.-Gen. Sir Wyndham Deedes: Great Britain and the Palestine Mandate.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at University College) at 6.—Dr. P. B. Ballard, T. Raymont, and others: Discussion on the recent Report to the Board of Education on Psychological Tests of Educative Capacity.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. G. Dawes Hicks: The Dynamic Aspect of Nature.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—W. Irwin: An Early Chapter in the Benzol Industry.

INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club), at 8.—A. Healey: Mechanical Structure of Rubber.

SCIENCE MASTERS' ASSOCIATION (Annual Meeting) (at University of Leeds), at 8.45.—Sir Berkeley Moynihan, Bart.: Presidential Address.

TUESDAY, JANUARY 6

SCIENCE MASTERS' ASSOCIATION (Annual Meeting) (at University of Leeds), at 10 A.M.—Prof. J. H. Priestly: Peat and the Plants that Grow upon it.—A. Yorkshire Problem.—C. B. Fawcett: The Distribution of Population.—At 12, Prof. R. Whiddington: The Trend of Modern Physics.—Prof. R. W. Whytlaw Gray: The Inert Gases.—At 5.30, Prof. W. Garstang: The Songs of the Birds.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 2.30.—Prof. G. H. Hardy: What is Geometry? (Presidential Address).—Dr. H. B. Heywood: The Reform of University Mathematics.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (V.): The Habits of the Water-Beetle.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at Manchester), at 3.30.—Dr. J. E. Myers and F. Fairbrother: A Few Chemical Curiosities.

ASSOCIATION OF UNIVERSITY WOMEN TEACHERS (at University College) at 5.—Prof. F. Soddy: The Economics of Life.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—C. H. Wright: Some Considerations in connexion with the Measurement of Liquid Fuel Storage and Liquid Depths.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—T. H. Gant: Cobalt: Its Production and Some of its Uses.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section) (at Broadgate Café, Coventry), at 7.15.

WEST YORKSHIRE METALLURGICAL SOCIETY (at George Hotel, Huddersfield), at 7.30.—The Value of some Workshop and Laboratory Tests.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—Dr. N. S. Finzi: Some Developments in Deep-Radio Therapy.

WEDNESDAY, JANUARY 7.

SCIENCE MASTERS' ASSOCIATION (Annual Meeting) (at University of Leeds), at 10 A.M.—Prof. A. Smithells and others: Discussion on the Connexion between Science Teaching in Schools and Universities.

ROYAL SOCIETY OF ARTS (Dr. Mann Juvenile Lectures (1)), at 3.—Lt.-Col. G. M. Richardson: Dogs in War.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

GEOLOGICAL SOCIETY OF LONDON, at 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Prof. E. Mallett and A. D. Blumlein: A New Method of High-Frequency Resistance Measurement.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club), at 7.—O. Stott: Water Gauge.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—Dr. A. Russell: Presidential Inaugural Address.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

THURSDAY, JANUARY 8

LEAGUE OF NATIONS UNION (at University College), at 11.30.—Prof. H. G. Fleure: Geography and the League of Nations.

CHILD-STUDY SOCIETY (at University College), at 3.—Prof. E. W. MacBride: The Evidence for the Existence of Environmental Influence on the Course of Heredity.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (VI.): The Habits of Insects and the Work of Man.

LINNEAN SOCIETY OF LONDON, at 5.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. W. Taylor: Three-Wire Direct Current Distribution Networks: Some Comparisons in Cost and Operation.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—F. J. Lawson: Telephone Cable Practice.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—J. P. Maxwell: Osteomalacea in China.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow).—L. A. Legros: Traction across Rough and Roadless Country (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch) (at Cardiff).

FRIDAY, JANUARY 9.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Miss Beatrice Saxon Snell: Anglo-French Building Terms.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—N. Simpkin and F. S. Sinnatt: The Melting Point of Coal Ash: Part 2.—Prof. H. S. Taylor: The Properties of a Catalytic Surface.

WEST CUMBERLAND SOCIETY OF CHEMISTS AND ENGINEERS (at Workington), at 7.—E. H. Todd: The Structure of Matter.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—The Maintenance of High-Compression Oil Engines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Keighley: Colour and Sunshine, Some Mountain Villages of Southern France.

INSTITUTE OF METALS (Sheffield Section) (at Sheffield University), at 7.30.—A. H. Mundey: Die-casting.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—J. L. Taylor: Theory of Longitudinal Bending of Ships.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch) (at Leeds).—H. W. Bannister: The Scientific Treatment of Boiler Feed-Water.

INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Branch) (at Liverpool).—L. A. Legros: Traction across Rough and Roadless Country.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section).—R. F. Battey and J. Black: Debate on Diesel Engines: Four-Cycle v. Two-Cycle.

SATURDAY, JANUARY 10.

INSTITUTE OF METALS (London Section) (at Institute of Marine Engineers), at 7.30.—Dr. R. H. Greaves: Extensometers.



SATURDAY, JANUARY 10, 1925.

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2880, VOL. 115]

Science and Administration in East Africa.

THE members of the East African Parliamentary Commission, who returned to England on December 23, have not only a remarkable itinerary to record even in these days of rapid travel, but also, according to reports received from the five territories which formed the subject of their inquiries, a notable performance of work under peculiarly trying conditions. Moreover, their visit has been of special significance to scientific workers. Major Church, whose warm advocacy in Parliament of the claims of science to the greater support of the country and his exposition of the function of science in economic development led to his being charged with the responsibility of reporting on the scientific and medical services, and Mr Ormsby-Gore, Chairman of the Commission and again Under-Secretary of State for the Colonies, have both given abundant proof in their public utterances of their appreciation of the scientific aspect of the problems of East Africa ; their realisation of the imperative need for the augmentation of staffs of existing scientific departments ; for the re-establishment of scientific institutions which have been either abolished or neglected ; and for the provision of funds for a campaign against the greatest scourge in equatorial Africa, the tsetse fly.

To scientific workers in East Africa particularly, the visit of the Commissioners must have been a source of lively satisfaction, for they have been given little sympathy or encouragement in recent years. The appointment of the Economy Committee in Great Britain in 1922 for the purpose of reducing expenditure in public departments set an example to the colonial governments. But while the recommendations of Sir Eric Geddes for the crippling of our home research and technical services were tempered by the growing consciousness among all classes in England of the important part played by science in industrial development, those of his prototypes in East Africa met with no such opposition. Science departments were regarded generally as luxuries, and were either "axed" completely or made aware that their continuance for more than another year or two was contingent upon some tangible and material proof of their economic value. For example, the discovery of a rich gold reef by a geologist singly responsible for the geological work of a territory the size of Great Britain might be accepted as a justification for his continued existence. A suggestion by the victim that the discovery of minerals of economic importance was not his primary function, or that such discoveries could best be attained by a scientific and systematic examination of the geology of the country, would probably have been regarded, by the legal luminaries and administrative officers to whom was generally entrusted the task of reducing expenditure, as a confession of incompetence.

Although in the past year the ravages of disease among the human and animal population ; the desiccation of certain hitherto fertile tracts of country due to unrestricted forest fires ; the impoverishment of the soil and the increase of insect pests due to indiscriminate grass burning ; the urgency of the need for local supplies

of fuel for transportation, industrial and domestic needs other than timber; the clamour of settlers and natives and merchants for the protection of economic crops against insect pests and diseases due to their partial realisation of the grave consequences attendant upon the neglect of precautionary measures, have had their effect upon the governments concerned, there remains yet considerable confusion of thought regarding the application of science to these matters The mentality still exists which would starve research in tropical diseases because there had been no recent calamitous outbreak, would contemplate with equanimity the expense entailed by the forced removal of a population of tens of thousands from an infected area when disease overtakes it, but once the immediate catastrophe was past, relapse into the old indifference to research

It is fortunate indeed that men like Mr. Ormsby-Gore and Major Church were members of the Commission They made a special point of meeting every scientific officer available. In Northern Rhodesia the Commissioners met Dr May, who for many years has advocated heroic measures against the tsetse fly. Dr Dixey, the Nyasaland geologist whose recent discovery of dinosaur remains has aroused considerable interest in Great Britain, and whose discovery of coal in the Chiromo district with indications of a coalfield of vast dimensions is of the utmost importance to East Africa, was able to show Major Church round the scenes of his labours and to indicate what was urgently required in the nature of a geological survey. In Tanganyika Territory, Dr. Shircore and Dr. Butler discussed with him their divergent views regarding the relation of yaws and syphilis. Dr. Scott was able to show the tremendous improvement that he has effected in the sanitation of Dar-es-Salaam, which promises to eradicate malaria in this district. The Commissioners travelled far through the fly belts with Mr. Swynnerton, whose heroic measures against the tsetse fly will establish his reputation as one of the foremost personalities in East Africa. They visited also the Veterinary Research Laboratory at Mpapwa, where Mr Hornby is conducting a series of remarkable experiments to test the relative values of hyper-immunisation and immunisation In Uganda they met the important staff, consisting of Dr. H. L Duke, Dr G D. H Carpenter, and Mr. Fiske, whose investigations into sleeping sickness must form the basis of any campaign for the removal of this human scourge. There also Mr. Wayland and Mr. Simmons, the geologists, gave them a greater insight into their purely scientific work and their discoveries of oil in the vicinity of Lake Albert Nyanza than the mere perusal of their official report would indicate; and in Kenya Colony they were able to judge dispassionately of the effect of decentralisation of the research laboratories which followed the departure of Mr. V. H. Kirkman to Zanzibar. The visit to the Amani Institute in Tanganyika a few days before departing from Mombasa convinced Mr. Ormsby-Gore and Major Church also of the urgent necessity of carrying on the work started by Zimmerman under the German Government.

The Chairman of the Commission, in his public utterances, brought home to our East African communities the grave character of tsetse fly domination. Many of his hearers learned for the first time that two-thirds of Tanganyika Territory is practically unfit for human or animal occupation through the activities of this insect and that in every territory visited the fly is increasing. He suggested that the malign influence of the tsetse fly upon tropical Africa is such as to merit the endowment by all civilised countries of a group of research workers to investigate the special problems connected with it.

Major Church did well to remind his Mombasa audience of the disadvantages of parochialism, giving the decay of the Amani Institute as an illustration of his theme. Although that great botanical research institute is ideally situated for carrying out work of vital importance to the whole of tropical Africa, intercolonial jealousies have led each colony to evade making a contribution to its upkeep, with the inevitable results. He tentatively suggested also that the new bacteriological laboratories at Entebbe in Uganda might be supported by at least four of the East African territories owing to its advantages of situation. In the same way, the Veterinary Research Laboratory at Nairobi in Kenya Colony, founded by Mr. Eustace Montgomery, Veterinary Adviser to the Lake territories, might be considered as the principal veterinary research centre for East Africa, although the claims of the Mpapwa Laboratory in Tanganyika to this distinction must be considered. Both Dr. Walker at Nairobi and Mr. Hornby at Mpapwa have much to gain by association under one roof. On the other hand, the establishment of a research centre for investigations in connexion with tropical diseases other than sleeping sickness would be extremely costly, and in view of the present divergent lines of inquiry, and the sharp conflict of opinion regarding the nature of certain diseases, it is doubtful whether any advantage is to be gained at present by centralisation. But apart from any decision of the five territories to pool their resources to establish research centres catering for the needs of their populations, the need for co-ordination and co-operation between them is imperative.

Unfortunately, while it is admitted that the departments entrusted with human and animal pathological research are inadequately supported, in certain territories there is practically no provision for research of any kind. Not even the important discoveries of Dixey of Nyasaland, or the work of Wayland and Simmons in Uganda, have sufficiently stirred the imaginations of the members of the legislative councils in the other three territories to stimulate them to create geological departments. Very little systematic research is being done in these same three territories in connexion with their economic crops, namely, cotton, maize, coffee, sisal, and wheat, while the possibilities of cinchona plantations have never been explored.

It is hoped that this state of affairs will soon be remedied. Backed by the authority of the Commissioners, there should no longer be any excuse for timidity on the part of colonial governors, most of whom personally are fully alive to the necessity for scientific research, and it is sincerely hoped that they will without delay put bold estimates for its prosecution before the members of their respective Legislative or Executive Councils.

Roman Britain.

(1) *The Roman Occupation of Britain: being Six Ford Lectures delivered by F. Haverfield, now revised by George Macdonald, with a Notice of Haverfield's Life and a List of his Writings.* Pp. 304 + 9 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 18*s.* net

(2) *Roman York: the Legionary Headquarters and Colonia of Eboracum.* By Gordon Home. Pp. 204 + 30 plates. (London: Ernest Benn, Ltd., 1924.) 12*s.* 6*d.* net.

THE Ford lectures of the late Prof. Haverfield were delivered at Oxford in 1907. At the time of their delivery it could be said by the man best qualified to judge, "that the enquiry into the history and character of Roman Britain, with all its defects and imperfectations, has been carried much farther than the enquiry into Celtic or Saxon Britain, much farther, too, than the enquiry into any other Roman province, and that our scientific knowledge of the island, however liable to future correction and addition, stands by itself among the studies of the Roman Empire." It was, in fact, high time for such a summary of results and retrospect of the course of inquiry as might be expected from a Ford Lecturer.

(1) Haverfield was not, however, the man to publish immature work. To those who were privileged to hear them, even if they had worked with him and for him—and he had more truly founded a school than any of his contemporaries at Oxford—the lectures of 1907 were a revelation. Yet publication was postponed, the multifarious calls upon the time of a man as efficient and thorough in university business as he was in the direction of research; then the War, the separation of a man capable of great friendships from continental colleagues, the loss of so many of those younger men whom he had trained and inspired; the more urgent need, as it might well seem, to press on with current work and raise a new generation of workers—all this intervened; and the lectures appear now as a memorial volume, at once of their distinguished author and of the three hundredth anniversary of the Camden chair of ancient history, which he filled with such vigour and distinction.

The necessary revision of the drafts, and expansion on the lines projected by Haverfield himself, has been admirably done by Dr. George Macdonald. He has also supplied an intimate study of the man and his life's work, and a bibliography which, though limited to signed articles, and exclusive of book reviews, fills no less than eighteen printed pages, and runs to as many as twenty-five items within a year.

The study of Roman Britain is an instructive example of the ups and downs of scientific method. Quite early in the Saxon period, the standing monuments of Roman occupation, and the folk-memories of the surviving British, challenged attention and comment, and on the British side of the breach, there were traditions older still, of the coming of the Romans, and of Celtic resistance to them. There has never, therefore, been a time when the written history of our island did not begin with a retrospect of "Roman Britain." In the twelfth and thirteenth century renaissance, which gave us the University of Oxford, it was the same, with the new habit added, of describing the monuments, deciphering inscriptions—more generally practicable then than now, for a generation whose learned language was still Latin—and attempting to identify places and lines of communication.

The achievements, in this direction, of men like Henry of Huntingdon and Geoffrey of Monmouth, have been the sport and the despair of their successors; and their ghosts still haunt the local antiquary. Even quainter disservice was done by renaissance scholarship abroad, whereby, in great ignorance of topography or philology, "obsolete names of cities are set forth in modern fashion," as in Servetus's edition of Ptolemy. But the "Britannia" of William Camden was recognised, at its first publication in 1586, as opening a new era of research. It stands, indeed, by the side of the classics of natural philosophy as a pioneer of the "advancement of learning" Camden, however, though a great antiquary, was not a first-class scholar, nor of scrupulous accuracy or self-criticism among the temptations which beset all historians, and some of his fertility of imagination and slovenliness in detail has descended upon lesser men, along with his inspiration to systematic field-work Other handicaps were, the disfavour into which the Society of Antiquaries fell under James I., the divorce between this London institution, after its revival in Stukeley's time (1717–18), and the literary scholars of the Universities; and Stukeley's disastrous acceptance of the forged "Richard of Cirencester," which perverted almost everything that was written on Roman Britain for a full century after 1757

It was only gradually that the Roman occupation of Britain came to be conceived either as a well-marked and peculiarly self-contained phase of British history, or as the local aspect of Roman imperialism. The antiquarianism of the eighteenth century was the hobby of a few able amateurs Camden's classification of antiquities by counties stimulated much county-history and local patriotism of a competitive kind, but few attempts to comprehend either whole periods or natural regions. Then, the new movement in scientific thought which escorted revolutionary politics,

and the æsthetics of romance, found one of its characteristic expressions in a philosophy of history, and another in the regional studies appropriate to an age of nationalism. While Niebuhr, Ranke, and Mommsen were making history scientific, the squirearchy and the "literary and philosophical" societies made archæology popular and fashionable The "new rich" of the early nineteenth century, as of the seventeenth and the twentieth, followed the fashion; became collectors and sometimes connoisseurs; and the "classical" education administered, for similar reasons, to their sons perpetuated an acquaintance with Cæsar's work, at all events, as part of the outfit of a gentleman, though at some risk to his knowledge of either history or geography.

Probably there are few countries even now in which an interest in "Roman remains" lies so near the threshold of consciousness as in Great Britain, few, however, in which the notion of them as a subject of scientific investigation was, until recently, so remote even from the minds of many scholars

The last generation of explorers, indeed, has had almost as much to undo as to create. The ancient divorce between university scholarship and regional field-work, which was notorious in Camden's time, persisted within living memory; and in so far as they have been reconciled, it has been the work of two men, Haverfield himself and Pelham, his predecessor in the Camden chair. The characteristic English disbelief in anything systematic or expert, whether in training or in research, is hard to defeat. the distance between London and the older Universities hampers intercourse between literary scholars and the national storehouse of antiquities, the "little learning" of the local antiquary, and his invincible antipathy no less to the use of modern languages than to continental methods of study, have stultified the benevolence of local patrons, which has often been generous.

For this state of things there are two remedies, illustrated respectively by the two books under review: better scholarship and wider background of knowledge on the part of the local field-worker—and a book like that of Mr. Home on Roman York would have been impossible twenty years ago—and closer and more persistent supervision and correlation of the field-worker by what may justly be described as a head-quarters staff. For, as Haverfield frankly concludes, in his first Ford lecture, the reforms effected by Mommsen in particular in Roman history during the nineteenth century "make it doubtful if the amateur can in the future do any real good." "The whole subject has become much harder"; for "to-day, unfortunately, accuracy is necessary"; and if we seem not to know now a good many things which passed current with antiquaries half a century ago, it is due to ruthless critical revision by a few men of scientific training and experience.

This critical revision of our knowledge of Roman Britain has various opportunities and lines of approach, as the lectures in question demonstrate. The older historical geography dealt with political boundaries "described pictorially on a series of vari-coloured sheets": it is quickly giving place to a "wider and a wiser view" of the relations of geography and history, which "begins by studying the physical features of the world by themselves," and only afterwards attempts, in the light of this knowledge, "to deduce the influence of these physical features in any special period." Only so, as in the first lecture of this series, can the strategy, for example, of Claudius's campaign of conquest in A.D. 43 be appreciated, and the later operations of Agricola, Hadrian, or Ulpius Marcellus, and the revolt of Boadicea, or of the North in the days of Commodus, be set in their true perspective. Only so, too, in the light of continental work on the defences of other frontiers of the Empire, on the Rhine or the Danube, and in North Africa, can the details of legionary camps and outposts of "auxiliary" troops be seen as parts of an orderly scheme of occupation; and as Mommsen himself admitted, "you have such wonderful inscriptions in your North country; no land tells us more about the Roman army."

Similarly, the "Romanisation" of Britain is a special and exceptionally interesting example of a process which was going on, during the same four centuries, in many border-lands. Here again geographical conditions impose rather austere control; all higher culture being "confined to a definite area in the centre, the east, and the south of the province. . . . Outside that area we may search practically in vain for traces of civilised life. Inside it we shall find almost nothing else," for when the military situation was once defined, troops were not stationed where they would be out of action in case of trouble on the border. There are qualifications to be made, of course; "in particular, the midlands were thinly and poorly peopled," yet in Cambridgeshire, as Dr. Cyril Fox has shown more recently, it was during the Roman occupation that we can first trace any serious exploitation of the forest-ridden clay-lands. There is a practical moral to this midland emptiness: "amidst its great woodlands, and on its damp and chilly soil, agriculture can expand only under the exceptional conditions of a Napoleonic war. Pigs, sheep and cattle may flourish better. . . ." So history repeats itself, and Roman Britain in its broad geographical features was very much the Britain that we know.

More important was the life of the towns; and though the first novelty of Haverfield's pioneer essay on

"Ancient Town-planning" is necessarily lacking here, the sections on the origin, structure, and outlay of Roman British settlements the adaptation of Roman architectural conventions to British weather and Celtic habits and the pottery and other characteristic elements in the furniture of the houses so developed receive much fresh illustration and commentary and no less perpetual challenge to traditional misconceptions whether the true story be available as yet or not

Especially is this suspension of judgment out of very fullness of knowledge apparent in the last of these lectures entitled Roman Britain and Saxon England and dealing with a state of things of which the writer frankly says that if for one reason it is not to be called a period for another reason it can hardly be called history Like the Bronze Age or the Early Iron Age it lies outside the ordinary range of historians

The early history of the English has been written often enough But it is mostly fiction The Celtic world is equally unhelpful I do not think I have exaggerated the general uncertainty which overhangs large parts of Celtic studies Here assuredly is no place for a respectable historian In Roman Britain on the other hand even for so severe a sceptic ancient history comes to the rescue of modern archæological detail purging the rhetoric and errors of Gildas But legend is history personified in fiction When we can test legends the general history proves usually to be true The heroic age remains—without the heroes The struggle between Roman British culture and Saxon barbarism was on a small scale truly compared with the great continental movements of that age but it was evenly balanced and fiercely disputed

Here archæology confirms legend utterly The conquerors were destroyers No case is known where Saxons dwelt in a Roman villa either by sack and burning or by evacuation the Roman towns ceased to exist as settlements as completely as those of the Danubian frontier of Noricum Geographical criticism comes to the rescue here too The Saxons advance 'went on to the same point as did Rome's and coots laid their eggs in the baths of Aquæ Sulis "Like Rome's it came to a stand at the foot of the hills" in more violent conflict with the Saxon Chronicle than with the surviving Britons But for the rest the Roman has passed from Britain as though he had never been. Once more, however this is the regional and, therewith, ephemeral view 'Had Rome failed to civilise, had the civilised life found no period in which to grow firm and tenacious, civilisation would have perished utterly But geographically Britain is an over-straits counterpart of what then was Gaul while Britain became England, Gaul became France, and in the longer story of the Romanisation of the Frank and through him of Saxon and Angle over straits we have the link which makes the history of Roman Britain a chapter consecutive with our own

(2) That a book like Mr Home's Roman York should find a public or a publisher at all is testimony to the real and wide interest in Roman studies to which allusion has already been made When we consider as the author notes in his preface that the total number of original references to York in extant Latin literature is five and that the remainder of its history must be reconstructed like a mosaic from indirect references and inferences in the light of epigraphic and archæological evidence we realise the amount of laborious compilation which goes to a book of more than two hundred pages It is indeed at the same time rather more than a history of Roman York and a good deal less than a survey of Roman Britain but the preface disarms criticism of its discursiveness and indeed Mr Home has only applied to a particular site the method of illustration from other places and districts which gives their value to the Ford lectures

Mr Home however is evidently not a trained scholar his Greek and occasionally even his Latin needs revision his references are few usually without chapter and verse in a note on p 59 all three titles refer to the same document! His English equivalents for Roman official titles are not always happily chosen his account of the status of *municipium* and *colonia* is obscure and he refers on p 76 to Huns in connexion with the events of A D 284 But he evidently knows York and its neighbourhood intimately he has had the valuable help of Dr Collinge Mr Foord and other local colleagues he writes vigorously and easily with a certain touch of imagination which gives coherence to a needlessly large mass of detailed information and he has illustrated his book with a number of excellent photographs He does not often mention Haverfield's work and occasionally falls foul of his opinions but knowingly or not he has learned in his school and his essay is living testimony to that revolution in method of which the Ford lectures are an epitome

Astrophysics without Mathematics

Modern Astrophysics By Prof Herbert Dingle Pp xxviii+420+46 plates (London and Glasgow W Collins Sons and Co Ltd 1924) 30*s* net

THE science of astrophysics has long since attained its majority It no longer needs the protecting presence of some more ancient science But it is at present almost devoid (at least in the English language) of that ordinary possession of a science—a literature It needs its classics its authoritative treatises its workaday text books its popular expositions, its

works of compilation and its works of criticism, its manuals of theory and its manuals of practice

Prof Dingle s Modern Astrophysics is a pioneer attempt at a popular exposition of the subject As stated in the preface the book is intended for the general public and the popular appeal has been given first place It is also comprehensive Its aim is to put a reader without specialised knowledge—either of physics astronomy or mathematics—in possession of the main range of facts of observation and of the theories propounded to explain them

It may be said at once that not only is there no book in English whi h even attempts this but also that Prof Dingle s book does in some measure achieve its aim The demands on the non technical reader are probably greater than the author supposes but he who is prepared to face four hundred pages of somewhat amorphous prose is conducted twice round the whole existing observational material is taken to some of the bounds of existing knowledge and is invited to peer into the recesses of the unknown The author con scientiously faces what h e considers to be difficulties and the book abounds in independent criticism though not all of it is wise The popular reader will however feel that the greatest respect has been paid to his intelligence and that he has been brought to the point at which he can at least frame sensible speculations of h s own

In collecting and arranging the facts Prof Dingle has expended a great deal of labour—labour which will make easier the future tasks of others For he has at least got the subject into a whole though rather a shapeless one In this connexion it may be regretted that references are almost non existent If these had been given even only for the tables the professional reader would have been greatly helped and the non professional one would not have been unduly terrified

The book would have been improved if the frequent dramatic and rhetori al passages had been omitted for they do not succeed in stimulating the reader s emotions more than would simple narration The author says that lack of space has compelled him to be brief This shows want of self criticism The book suffers from diffuseness Repeatedly loss of clarity arises from excess of explanation Though possessing the literary form of a popular work it has the dimensions and price of a treatise and if it had been reduced by one third and better provided with sub headings it would have been more readable and nothing of value need have been omitted

When one of the objects of the book is to give non mathematical explanations it is disappointing to find how often opportunities have been missed It is possible to show very simply in words, how the angular diameter of a star is connected with its surface brightness, how observations of eclipsing binaries yield determinations of stellar densities, and how the detection of a moving cluster plus a single determination of radial velocity affords good determinations of parallax These are three simple fundamental relationships Yet in Prof. Dingle s text the first is confused with the irrelevant introduction of parallaxes and the linear diameters of stars the second is stated but not argued out at all and the third is omitted save for a reference to the fact that if the parallax of one star of a moving cluster can be found those of the remainder follow from the common velocity Similarly no attempt is made to show why the period of a Cepheid should be expected to decrease with increasing density

This is the more to be regretted in that occasionally the author conveys much in little in an illuminating epigram for example when he remarks that though novæ have been classed as variable stars it is doubtful if such a classification expresses anything more than the philosophical instinct which craves after generalisation or again referring to the maintenance of energy evidently one of the star s most important functions the expression of its instinct for self preservation And such a sentence as A variable star is not the opposite of a fixed star is a charming example of tenderness for the difficulties of non professional brethren

Serious criticism can be made of the actual substance of parts of the book for example the chapter on the sun contains a long description of the rival theories of the gaseous photosphere and the cloudy photosphere, and the author gives the impression and evidently himself believes that there is little to choose between them Surely this is to speak the language of a previous decade It may be regarded as completely certain, and is believed on reasoned grounds by the overwhelming majority of astrophysicists that the photosphere does not consist of opaque incandescent clouds The author largely ignores the accepted results of mathematical investigations whilst attempting to traverse the same ground verbally for example the difficulty that has usually been encountered as soon as we leave the primrose path of verbal argument and introduce a few numerical estimates of orders of magnitude is that the sun s boundary ought to be more sharp than it is not less sharp

Again in dealing with the interior of a star the author shows how radiation is handed on from layer to layer and gives an indication of how the effect has been calculated by Eddington But in dealing with the sun he remarks how the energy distribution would be related to the huge range of temperature from the sun s centre to its surface is indeed a difficult problem It may be doubted whether the relation

would have much analogy with that observed when an isothermal surface is the radiator" This is not the only failure on the part of the author to assimilate different researches Though there is an introductory section on the theory of spectra, much of the book is written in the language of the era before a theory of spectra existed It would surely be easier for the ordinary reader to understand resonance radiation and fluorescent radiation rather than to be mystified by "non-temperature" radiation Referring to Wolf Rayet stars, Prof Dingle says 'The Wolf Rayet stars seem to be the only ones that behave as a wholly gaseous mass should Their spectra are intelligible—a faint continuous spectrum due to the light from the high-pressure interior which has managed to escape, with a bright line spectrum from the surface layers impressed on it" Prof Dingle is entitled to state his intuitive expectations, but he is not entitled to ignore the fact that mathematical analysis shows that a star is to be expected to give an *absorption* spectrum, the difficulty is to explain the existence of bright lines On another page, however, he remarks that Wolf Rayet radiation in general is inexplicable" His attempted explanation of a bright line spectrum—that when a star reaches its maximum temperature its central parts are cooling whilst the outer ones are getting hotter—is inadmissible, as a simple calculation shows

The author suggests that the hypothesis of the synthesis of helium from hydrogen is in keeping with the observed fact that the second spectrum of a nova has weaker hydrogen lines and stronger helium lines He apparently fails to realise the exceedingly small mass of gas required to produce even intense lines, an amount utterly negligible compared with the amount either of hydrogen or helium probably available

Prof Dingle says that, as we do not know the precise conditions inside a cooled star, we are at liberty to make any assumption that is not inconsistent with the little we do know He then says that [illegible] nebulæ may arise from a catastrophic outburst in [illegible]led star, for "we cannot say this is impossible so long as the heat energy inside the star is sufficient to account for the gravitational potential energy of the nebula, and there is every reason to believe it is sufficient' But why this meticulous respect for the first law of thermodynamics when the second law is being thrown overboard? It is simply not fair to the non-technical reader to make unorthodox suggestions of this kind without fully pointing out the nature of their unorthodoxy

The looseness shown by these examples is unfortunately present in much of the reasoning Astrophysicists will use the book for its summaries of facts, but they will be little helped by its theoretical discussions

E. A. M.

Blood Pressure in Early Life.

Department of Applied Statistics University of London, University College Drapers' Company Research Memoirs Studies in National Deterioration, XI Blood Pressure in Early Life a Statistical Study By Dr Percy Stocks, assisted by M Noel Karn Pp iii+88 (London Cambridge University Press, 1924) 12s net

DR PERCY STOCKS work entitled 'Blood Pressure in Early Life" immediately strikes one as filling a long experienced gap in medical literature Systolic and diastolic blood pressures are, indeed, taken to-day almost as a routine in the medical examination of a patient, and yet it is notorious how hazy are the conceptions of the normal range of these at different ages Especially is this the case in childhood and adolescence The principal aims of the author, therefore, were to investigate the behaviour of blood pressure during the period of puberty and adolescence, to ascertain the normal range of systolic, diastolic, and pulse pressures at ages from 5 to 40, and to examine the interrelation between these pressures and their correlation with pulse rate, physical development, muscular strength, respiratory and psychological factors, social class and athletic habits of life

The study, which is a statistical one, has brought out some extraordinarily interesting results, a few only of which we shall be able to mention The systolic pressure is found to rise as a simple function of age from 5 to 11 years The onset of puberty causes a well marked accentuation in the gradient until at the age of 19 a maximum of 130 mm of mercury is reached From 19 to 40 years of age no further change is detectable The comparatively rapid rise in systolic blood pressure during puberty is shown to occur even when the figures are corrected for body weight, which itself is positively correlated with blood pressure The diastolic pressure, on the other hand, shows an interesting divergence from the course of the systolic pressure in its rate of rise with age In this case puberty at first hinders the rise, but this delay is followed at the age of 18 by a rapid rise to a maximum during the 21st year Following this the diastolic pressure tends to fall somewhat up to the 37th year

It is evident from the age curves of systolic and diastolic pressures that the pulse pressure increases rapidly at the onset of puberty to reach a maximum about the age of 18, after which it decreases equally rapidly into the 21st year, afterwards increasing again as a simple function of age

These are some of the facts elicited by this statistical study Their explanation is, however, difficult Dr

Stocks incriminates the endocrine glands in the causation of the rapid rise in systolic pressure during adolescence. Experimental evidence, however, is against any pressor action by the sexual hormones, although the possibility of the suprarenal and pituitary bodies being in part or in whole responsible for this change cannot be excluded.

The product of pulse pressure and pulse rate is found to show a well-defined maximum during adolescence, the curve representing this product plotted against age showing a superficial resemblance to that of rate of growth in body weight The author tentatively agrees to the contention that this product is "an index of cardiac energy expended per minute in maintaining the circulation," and even gives this contention the dignity of an algebraic notation. We would point out that the static factor in the total energy expenditure of the heart per minute is proportional to the product of the minute output and the mean blood pressure during the ejection phase of cardiac systole, and is in no direct manner connected with the pulse pressure. Indeed, the fallacy of Erlanger and Hooker's suggestion was conclusively demonstrated by Miss Skelton, who found that the relation between the pulse-pressure pulse-rate product and cardiac output in the isolated mammalian heart varied enormously, in one experiment between 7 to 1 and 47 to 1

Again, in adults, assuming that the average output per beat remains fairly constant up to middle life, and assuming that the pulse-pressure pulse-rate product is an index of the energy expended by the heart per minute, the author draws the conclusion that the mean product of pulse rate and pulse pressure is directly proportional to the mean work done by the heart per minute, which is merely one of the author's original assumptions. Figures calculated on the further assumption, that the mean output per beat in large groups of growing individuals is proportional to the mean body weight of these groups, show that if the assumptions are justified one "must conclude that, when the age of 16 has been reached, the average heart is performing as much as or more gross work per minute than in adult life, in spite of the fact that it has presumably not attained full size."

Thus many of the conclusions of the author are based on the assumption that the pulse-pressure pulse-rate product is an index of the work done by the heart. We repeat that the experimental evidence strongly militates against the validity of this assumption. This, of course, merely throws doubt on the interpretation of Dr. Stocks' statistical figures. The results obtained are of absorbing interest and undoubtedly will be of great value to medical officers of schools and of insurance companies.

Our Bookshelf.

The Physiology of Photosynthesis. By Sir Jagadis Chunder Bose. Pp. xx + 287. (London: Longmans, Green and Co., 1924.) 16s. net.

LIKE all the monographs from the Bose Research Institute, this book contains an account of new and very ingenious experimental methods, and a discussion of experimental results, so detached from the general current of plant physiological literature that it becomes difficult, if not impossible, to assimilate the new data into the fabric of the science. Practically all experimental work is carried out upon the water plant *Hydrilla verticillata*, a most ingenious bubbling method being used to record the rate at which oxygen is released during photosynthesis

The presence of nitrogen in the gas expelled from the plant is prevented by supplying the plant with water free from nitrogen, but where experiments are being carried out in varying concentration of carbon dioxide, the earlier work of Devaux on the intercellular atmosphere of water plants suggests caution in the interpretation of experimental data This method, however, rendered automatic by an electromagnetic device registering on a recording drum, should prove of very great value and have many applications.

Two other methods are also used; in one the rate of oxygen discharge is recorded by the change of buoyancy in a submerged shoot attached to a torsion balance; in the other the bubbles are removed by raising the shoot out of water and then measuring afterwards, either in a torsion balance or a precision chemical balance, the change in *density* of the submerged shoot due to the accumulation of assimilates which are assumed to be carbohydrates. Osmotic and turgor charges with their consequent effects upon the volume of the intercellular air system are apparently disregarded in this method.

As to experimental results, Prof. Bose has previously briefly reported in NATURE (July 21, 1923) the great sensitiveness of the process of photosynthesis to certain substances, as, for example, to the slight amount of nitric acid carried down into the ponds after thunderstorms. Many of his more general conclusions will probably not attract so much attention as the new experimental methods he has employed.

The Cultivation of New Zealand Plants. By Dr. L. Cockayne. (New Zealand Practical Handbooks.) Pp 139 + 21 plates. (Auckland, Christchurch, Dunedin, Wellington, Melbourne, and London: Whitcombe and Tombs, Ltd., n.d.) 4s. 6d.

DR. COCKAYNE deserves the thanks of those interested in horticulture, both in New Zealand and in the British Isles, for his excellent practical book on New Zealand plants. It is of particular value for plant lovers in New Zealand, since he brings to their notice the many remarkable native plants which gardeners are so apt to neglect. It is too often the case abroad to find that residents, who may have come from the Home Country, desire only to grow those plants they have known at home, and often neglect almost entirely the native plants of their country of adoption. Similarly, in Botanic Gardens in the Colonies, it is common to find the native flora very largely neglected and mainly a

fine collection of exotic plants under cultivation From Dr Cockayne's book it is clear that in the New Zealand Botanic Gardens, care is taken to cultivate as representative a collection of the native plants as may be possible, and the efforts which have been made in this direction are worthy of the highest praise

Now, thanks to Dr Cockayne the same aim is made possible and easy to all lovers of gardens in New Zealand as he gives full particulars as to how the plants should be procured and cultivated and then goes on to give lists with good descriptive accounts and methods of propagation of the native trees shrubs Veronicas herbs, climbing plants, and ferns suitable for gardens There is also an interesting and very useful chapter on native plants suitable for town gardening The book is well illustrated with a number of excellent plates and is also furnished with a map and full index

Das Wildseemoor bei Kaltenbronn im Schwarzwald ein Naturschutzgebiet Von Dr Karl Müller Pp vi +161+19 Tafeln (Karlsruhe i B G Braun G m b H 1924) 3 marks

The author spent thirteen years in the study of a particular piece of moorland vegetation in the vicinity of Baden Baden The area is noted for its beauty and Dr Müller loves the region—a fact that contributes largely to the fascination of the book But not only is the Wildsee a lovely spot it is also of peculiar interest to the student of natural history In his preface the author states that the fauna and flora of the moor is that of the arctic alpine type comparable to an island in the midst of a sea of central European forest produced by the ecological singularity of its position Beginning with the history of the moor from the eighteenth century, he traces its life from 1780 when its water supply was originally tapped Later the peat itself was exploited During these periods the drained areas were utilised for afforestation schemes with conspicuous failure—sphagnum growing most freely on those areas from which the peat had been taken and reconverting them into bogs Since the Armistice the author's knowledge of the region and his numerous articles upon it have assisted in the postponement of further projects to use the peat and we are glad to learn that this beauty spot will be converted into a national preserve The book is well illustrated with photographs and maps but unfortunately it does not possess an index though it has a good table of contents It will appeal to all lovers of Nature and to students of ecology, for it contains much useful material attractively arranged regarding moorland vegetation It was written originally to interest all who know and love this beautiful part of the Black Forest.

Lectures on the History of Physiology during the Sixteenth, Seventeenth and Eighteenth Centuries By Sir Michael Foster Second impression Pp vii+306 (Cambridge At the University Press, 1924) 15*s* net

The history of the development of medicine has been told many times, but rarely can we gather from these accounts a clear history of the two subjects, anatomy and physiology, on which the whole structure of the art of healing is built The late Sir Michael Foster's book consists of the "Lane Lectures" delivered at the Cooper Medical College in San Francisco in the year 1900, and gives a detailed narrative of the progress of physiology in the sixteenth, seventeenth and eighteenth centuries In one important detail it differs from many books of its type it is the history of the science not merely of the lives of scientific workers Yet there is included much about the personal histories of the pioneers of physiology which stimulates additional interest in the fruits of their labours The author sees in the efforts of Vesalius against the blind dogma of the Middle Ages the foundations of modern physiology and modern anatomy Harvey's great work he regards as the direct outcome of those efforts The influence of advancing knowledge of physics and chemistry is demonstrated in the ideas of Borelli Paracelsus and Franciscus Sylvius In Mayow's realisation of the functions of what is now called oxygen there is an illustration of how a great scientific discovery may be completely ignored in its time and find recognition after more than a century

The value of this book may be indicated by quoting the author's own words It is one of the lessons of the history of science that each age steps on the shoulders of the ages which have gone before The student will find in the book an account of this progression which will enable him better to understand the physiology of his own age

Antiques their Restoration and Preservation By A Lucas Pp viii+136 (London E Arnold and Co 1924) 6*s* net

Mr Lucas's book forms a very useful introduction to the modern methods of treatment of antiques on which subject very little literature has hitherto been available, but being written in as non technical a manner as possible it is likely to be of more value to the antiquarian than to the chemist

The work is divided into four chapters the first two giving a general outline of methods of treatment while the third is devoted to their application to specific materials A short final chapter gives certain simple tests for determining the composition of objects

While the majority of the methods recommended in the third chapter have been found to be safe yet certain of the author's methods would be dangerous in inexperienced hands For example the treatment of papyrus by soaking in water is somewhat drastic Papyrus which is composed of small sheets stuck together is very liable to disintegrate under treatment, and it is safer to cover it with moist blotting paper But in most cases the author has confined himself to describing methods of proved utility which provided the fragility of antique objects is borne in mind can be used by any one He is however, rather unduly fond of the use of paraffin wax to which cellulose acetate is usually to be preferred

Some of the tests given in the fourth chapter may be misleading to those ignorant of science The methods given for determining specific gravity are likely to be very inaccurate Since the object must in any case be weighed in air, it would be better to instruct the reader how to weigh it in water, for only thus can an opinion be formed as to the genuineness of, for example, a coin But these are comparatively small faults in a book which all antiquarians will be well advised to study R A M

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

On the Luminescence of Solid Nitrogen and Argon.

A LETTER in NATURE of November 15, by Prof. L. Vegard, contained some statements regarding the work of Dr. Shrum and myself on the luminescence of solid nitrogen and argon that would appear to warrant some comment from me. Prof. Vegard's article appears to give the impression that our discovery that the band near $\lambda = 5577$ Å in the spectrum obtained with solid nitrogen had a triplet structure with none of the components coinciding with $\lambda = 5577{\cdot}35$ Å was made after he himself had noted this fact. A reference to our paper will show that it was received by the Royal Society on June 14 of this year. A brief notice of it appeared in NATURE of July 5.

Although we had found late in January 1924, or early in February, that this band, now called N_1 by Prof. Vegard, had a triplet structure, we withheld publication of that fact until a paper by Prof. Vegard should appear, because we inferred from reports appearing in the daily press about that time that he had found the auroral "green line" in the spectrum of solid nitrogen bombarded by electrons.

As no reference to the triplet structure of the N_1 band was made in Prof. Vegard's paper that appeared in *Comptes rendus* of March 31, or in that published in the issue of NATURE for May 17, we communicated our paper to the Royal Society on June 14. On June 17 Prof. Keesom communicated to the International Congress on Refrigeration a paper by Prof. Vegard summarising the latter's work, and dated May 13, with an appendix dated May 31, and a further one dated June 13. In this paper, and in its appendices, again no reference was made by Prof. Vegard to the structural character of the N_1 band.

At the conclusion of the presentation of Prof. Vegard's paper at the Congress of Refrigeration, I was permitted to show our photographs of the solid nitrogen spectrum in which the structure of the N_1 band was revealed. In a paper in *Comptes rendus* of July 7, Prof. Vegard referred for the first time to the fact that the N_1 band had a triplet structure. This paper, therefore, confirmed our results, although no mention was made in it of our work, which was known to Prof. Keesom and others from the Leyden laboratory, on June 17. Again, in a later paper in *Comptes rendus*, July 21, Prof. Vegard dealt with the subject, but again made no reference to our work. It is not conceivable that Prof. Vegard observed prior to June 13 that the N_1 band had a triplet structure with none of the components coinciding with the auroral green line, and withheld that very important fact in the communications of his results obtained up to June 13.

Prof. Vegard suggests that differences between his observations and ours "may be partly due to the fact that their [McLennan and Shrum's] experimental material was very limited, and that their arrangements made it difficult to overlook the experimental conditions and to vary them in a known way." Prof. Vegard apparently is not familiar with the equipment available in the Physical Laboratory at Toronto for researches of this character. Many scientific workers who have visited our laboratory will be able to support me in the statement that our cryogenic and spectroscopic equipment is amply sufficient to meet far more exacting demands than those presented in this investigation. A casual glance at the reproductions of our photographs will show, too, that we were not ignorant of the best methods of using this equipment. Again, Prof. Vegard states that our difference of opinion does not originate from a difference with regard to experimental facts. If we, with our experimental arrangements, were able to obtain the same experimental facts as he did, then he can scarcely maintain that our experimental arrangements made it difficult to "overlook and vary the experimental conditions."

The experimental facts in so far as we know them are as follows:

We found that when solid nitrogen was bombarded with electrons, the luminescent band N_1 consisted of three "broad lines or narrow bands," with mean wave-lengths $\lambda = 5654$ Å, $\lambda = 5617$ Å, $\lambda = 5556$ Å. Prof. Vegard has found the same structure, but with the mean wave-lengths $\lambda = 5649$ Å, $\lambda = 5611$ Å, and $\lambda = 5555$ Å.

We found that solid nitrogen, when made to phosphoresce by electronic bombardment, gave a spectrum consisting in the visible region of a single broad line or narrow band at $\lambda = 5231$ Å. Prof. Vegard finds the wave-length of this narrow band to be $\lambda = 5229{\cdot}4$ Å.

We found that the spectrum of pure solid argon, when the latter was bombarded by electrons, contained a band consisting of two components, one of them being strong with a mean wave-length at $\lambda = 5607$ Å, the other faint with a mean wave-length at $\lambda = 5648{\cdot}3$ Å.

Prof. Vegard, when bombarding solid argon containing varying amounts of solid nitrogen with electrons, found a spectral band consisting of several components with the strongest member having a mean wave-length at $\lambda = 5604$ Å.

We found, when great precautions were taken to purify the argon we used, and only when such precautions were taken, that solid argon phosphoresced after bombardment by electrons, and that the phosphorescence spectrum of argon so treated consisted in the visible region of two broad lines or narrow bands at $\lambda = 4750$ Å and $\lambda = 5300$ Å. This phosphorescence spectrum of solid argon Prof. Vegard does not appear to have observed as yet.

Prof. Vegard takes the view that the results of his solid nitrogen-argon experiments indicated the oscillation of the principal maximum in the N_1 band between $\lambda = 5555$ Å and $\lambda = 5604$ Å.

We feel inclined, however, to the opinion that his results in this connexion indicate that he obtained a mixture of the N_1 components of the nitrogen band and of those of the argon luminescence band in the same region. It may be added that, in our experiments, we found the positions of the components of the N_1 nitrogen band, as well as that of the N_2 phosphorescence band, the same with the solid nitrogen at the temperature of liquid helium as at the temperature of liquid hydrogen.

Our experiments, it may also be stated, did not preclude the possibility of the components of the N_1 nitrogen band originating in the cold vapour of nitrogen in contact with the solid nitrogen. Prof. Vegard is of the opinion that these component spectral bands originated in the solid nitrogen only. He concludes that if the particles of the bombarded solid nitrogen were gradually reduced to molecular dimensions, the N_1 composite band would degenerate finally into the very fine auroral line $\lambda = 5577{\cdot}35$ Å. It is difficult for me to follow him to this conclusion.

It seems to me that in an examination of the

validity of Prof. Vegard's theory, some useful information might be gained by directing more attention to the *phosphorescence* of solid nitrogen. Does the phosphorescent nitrogen band $\lambda = 5231$ Å appear in the spectrum of the aurora or not? If it can be shown that it does, we shall know that the region in which the auroral light originates is at or near the temperature of liquid hydrogen. If this line does not appear in the spectrum of the aurora, and if the temperature of the region in which the radiation constituting auroral spectra originates is at or near the temperature of liquid hydrogen, then why does the phosphorescence nitrogen spectral band not appear along with other nitrogen bands found in auroral spectra by Vegard, Rayleigh, and others?

From Kayser's "Handbuch" one finds that a line or narrow band has been found by different observers in the spectrum of the aurora with the following wave-lengths: $\lambda\lambda = 5269$ Å, 5205 Å, 5200 Å, 5233 Å, 5210 Å, 5239 Å, 5207 Å, 5228 Å, 5235 Å, 5166 Å, and 5230 Å, but the list of wave-lengths observed by Vegard in the auroral spectrum and given by him in his paper in the *Phil. Mag.* of July 1923 contains no wave-lengths between $\lambda = 4708{\cdot}7$ Å and $\lambda = 5578{\cdot}2$ Å. It appears, however, from a statement in one of his more recent papers, that he has observed in the spectrum of the aurora a trace of a line near $\lambda = 5230$ Å. Cario has found a band in the spectrum of oxygen near $\lambda = 5230$ Å, and Prof. A. Fowler recently pointed out to me that Ångström and Thalen found a negative band in the spectrum of nitrogen at $\lambda = 5227{\cdot}5$ Å. It seems very desirable, then, to repeat the observations on the auroral spectrum to see if there is any trace of a wave-length at or near $\lambda = 5231$ Å. If such a spectral line or band should be found, it would be well to have a very exact determination of the wave-length made in order to decide whether the corresponding radiation originates in nitrogen in the gaseous or solid state, or in some other element in one or other of its states.

It is unfortunate that Prof. Vegard's brilliant prediction has not as yet received experimental confirmation. It would appear that neither he nor we have as yet obtained with nitrogen or argon, or with mixtures of these two elements at the temperatures of liquid hydrogen or helium, by the use of any agent, a spectrum that includes a broad line or narrow band within a region of 10 Å on either side of the famous "green line," the wave-length of which, according to measurements made with great precision by Babcock, is $\lambda = 5577{\cdot}35$ Å. Nevertheless, Prof. Vegard's theory has been most stimulating, and has led already to the discovery of valuable and important experimental results.

J. C. McLennan

The Physical Laboratory,
University of Toronto, December 6.

The Life of Lord Rayleigh.

History should have as little fiction attached to it as possible and evidence should be tendered in time, by those who can speak with knowledge: this view may not be in accordance with practice, none the less, it may be advocated as desirable doctrine, especially as it has the authority of the author of *Zadig*—a saint recommended for worship by Huxley—who has said:

> On doit des égards aux vivants,
> On ne doit aux morts que la vérité.

All who knew the late Lord Rayleigh even distantly—he was very difficult of approach—will agree with Sir J. J. Thomson (Nature, December 6, p. 814) that his son has written his Life with remarkable skill and sense of proportion—but some of us can scarcely admit that nothing more is to be said even of the discovery of argon. The account given is only partial, in no way a complete presentation of the episode; among others, we should like to have heard the views of Gordon, the discoverer's devoted laboratory servitor. Lord Rayleigh was but young at the time of the achievement and cannot have been aware of the state of feeling among chemists—nor, probably, was his father; he will not know in what reverence we held his father's work. I suppose I was behind the scenes as much as anyone, the more as I was president of the Chemical Society, was thoroughly acquainted with Ramsay and his ways and, as is well known, an intimate friend of Sir James Dewar.

At the annual general meeting of the Chemical Society, on March 27, 1895, I made the following statement, to the fellows, in my address.

> Your Council have decided to appoint Lord Rayleigh our Faraday lecturer and to request his acceptance of the Medal in recognition of the important service which he has rendered to Chemistry by his discovery of Argon.

I handed the medal to him from the presidential chair—he accepted it. His guarded remarks in acknowledgment are on record in our Journal. The Chemical Society advisedly took the view that it was *his* discovery. There was the strongest possible feeling among chemists that his name alone should have been associated with the discovery. I may add that, on the same occasion, I had the pleasure of calling upon Ramsay to make public his startling discovery of helium in cleveite, which was thereupon confirmed by Crookes.

Lord Rayleigh has dealt mainly with his father's electrical work (on the ohm and the ampere) and that on argon. Probably some of his readers are disappointed that he did not also summarise his activity in other directions—particularly his work on oil films and capillarity, which is proving to be of special interest and importance in our field. If I be not mistaken, the part he took in such inquiry is not sufficiently recognised. If another edition be called for, let us hope that a chapter on his work in general will be added.

As to my friend Sir Joseph Thomson's gibe at chemistry—what is chemistry? I hold that chemistry and physics are inseparable disciplines, the parting line a broad valley through which both flow; the pity is that physicists so rarely stray from their own region up the chemical slope, that their vision is so little adjusted to our country. They suffer, indeed, from *Chemo-myopia*, not *Chemotaxia*, I fear the fault is congenital. Apart from Regnault and Rayleigh, I believe determinations of the density of gases are all but entirely the work of chemists—has not Sir Joseph heard of Avogadro's theorem and of one Cannizzaro, a chemist and Roman Senator? The determination of gaseous density is *the* fundamental operation in chemistry, as he will see if he consult a bygone classic, Cooke's "New Chemistry". Gaseous density is the foundation stone of our entire numerical system. What, however, can they know of chemistry who only physics know? Indeed, there would seem to be a constitutional aversion from our science in the mind of the physicist—he lacks the necessary freedom of outlook to appreciate our numberless excursions. The slowness with which Lord Rayleigh saw the treasure beneath his feet was probably owing to the fact that he had little real chemical feeling; Ramsay at once appreciated the value of the find when asked to inspect the ground and took shares without hesitation.

Henry E. Armstrong.

55 Granville Park,
Lewisham, S.E.

The Adhesive Apparatus of the "Sucking-fish."

EARLY in 1923 I published in NATURE a short summary of my views regarding the mechanism of the so-called suckers of certain hill-stream fishes and of the "Sucking-fish"—Echeneis.[1] My conclusions were based on an examination of the living specimens of two Indian genera of hill-stream fishes —Pseudecheneis and Glyptothorax, and on a study of preserved material of Echeneis. Later, at my request, Major R. B. Seymour Sewell, Surgeon-Naturalist to the Marine Survey of India, very kindly performed a series of experiments on living specimens of Echeneis. Quite recently (September 1924) I have been able to conduct a few experiments on the "Sucking-fish" in the Marine Aquarium at Madras. In carrying out these experiments I received great help from Dr. Sundara Raj, acting director of the Madras Fisheries, and Prof. H. Parameswaran, of the Presidency College.

The following experiments were carried out to test the sucker-theory of the disc of Echeneis —

A smooth tin sheet perforated all over with minute holes was taken, and the fish was allowed to attach itself to it. It was observed that the animal was not able to stick to such a surface. This experiment was repeated with a piece of fine-meshed wire gauze in place of the tin sheet with similar results. A wooden plank with a large number of parallel grooves running across it at short distances was next used in place of the wire gauze. The fish could not adhere to such a surface.

In all these experiments it was observed that the fish did not like to have its sucker placed against either very rough or perforated surfaces. Moreover, on such surfaces it secreted large quantities of mucus from its disc. In all probability this secretion helps the fish in sticking to rough surfaces.

The fish was next allowed to adhere firmly to a smooth sheet of glass or a tin sheet. It was found that on such smooth surfaces the fish could be made to slide forwards and sideways without any difficulty, but a certain amount of force was needed to pull it backwards or vertically upwards. When pulled vertically upwards, the resistance against the pull is due to the sucker formed by the disc; while the force resisting the pull in the backward direction is due to the mechanical frictional device formed by the innumerable backwardly directed spines on the lamellæ of the disc. When lifting the fish vertically upwards it was observed that the entire outer rim of the disc formed a big sucker. In the next experiment the formation of the sucker by the entire rim of the disc was rendered impossible by introducing a number of match sticks under the rim. It was then discovered that a double series of secondary suckers were also formed between the transverse lamellæ on the two sides of the central axis of the disc. This was confirmed by gradually lifting the disc from behind, when it was noticed that each secondary sucker gave way with a hissing sound. It may also be noted that the secondary suckers produced between the lamellæ are not only independent of the outer large sucker, but are also independent of each other.

The disc of Echeneis, when in action, is therefore composed of an outer sucker formed by the rim, and of the two rows of secondary suckers formed in the grooves on either side of the central axis. At the same time, the spines on the lamellæ prevent the fish from slipping off whenever the animal is pushed backwards. The usefulness of the spines for attachment comes into play when the "Sucking-fish" is adhering to such fast-swimming animals as sharks and whales.

The case of the hill-stream fishes is somewhat different. They have only to contend against a rapid-running current constantly flowing in one direction. Suckers under such conditions are probably less useful than non-slipping frictional devices. This is beautifully illustrated by the various Indian species of the genus Garra.[2] In species of the genus which live in lakes and comparatively still water (*e.g. G. mullya, G. gravelyi*), the mental disc is large, and the adhesive pads on the under surface of the paired fins are feebly developed, while in species which inhabit rapid-running streams (*e.g. G. kempi, G. gotyla*) the disc on the under surface of the head is somewhat reduced and the non-slipping adhesive apparatus on the under surface of the paired fins is well developed. The frictional device in the case of these fishes is more useful than a vacuum sucker. The strength of a vacuum sucker is limited according to its area, while friction increases with pressure, and this in hill-streams increases with the rapidity of the current. The similarity in shape between the anterior dorsal profile of the hill-stream fishes and the anterior ventral profile of Echeneis shows similarity of purpose, which is to utilise the force of the current for increasing the pressure on the disc and thus to make it stick more firmly to the substratum.

SUNDER LAL HORA.

Indian Museum, Calcutta,
November 4.

[1] Hora, NATURE, 111, p. 668 (May 19, 1923). See also Rec. Ind. Mus. 25, pp. 587-591 (1923).

IN order to test the action and mechanism of the disc in Echeneis and determine whether or not one function of the disc is to act as a sucker (in the strict sense of the word) a series of experiments were carried out.

Specimens were allowed to attach themselves to clean sheets of glass, and the disc was then examined and compared with the surface of the disc when unattached. In the unattached state the rim of the disc is soft and flexible, and around the anterior half of the disc the margin is distinctly raised while the posterior half is flat, the transverse ridges, on which are numerous posteriorly-directed spines, lie flat against each other and present a practically continuous surface. When the animal has attached itself by the disc, the smooth flexible margin can be seen to be closely pressed against the glass. The ridges running transversely are now separated from each other by narrow spaces, the two series, *i.e.* right and left, being separated by a median soft band that passes backwards in the middle line. At the posterior end this ridge stops short, so that the terminal posterior part of the sucker is occupied by a single large cavity the floor of which is depressed. Air bubbles can be seen between the ridges and in this posterior chamber, and such bubbles may be seen passing along each side of the median partition into the posterior chamber.

When thus attached, if the posterior rim of the sucker is separated from the glass, air immediately enters the posterior chamber, and by slowly pulling the sucker away, each pair of spaces between the transverse ridges can be opened separately, each giving way with a slight sucking noise; each compartment of the disc thus appears to act as a separate sucker.

When once the fish has attached itself by the disc it can be moved forwards or sideways easily, the disc sliding over the plate, but on attempting to pull the

[2] Hora, Rec. Ind. Mus. 22, pp. 533-587, pls. xxiv.-xxvi. (1925).

fish backwards, the spines on the ridges of the disc come into action and tend to prevent any backward movement; and if the disc is forcibly pulled backwards the spines can be heard scraping over the surface. If pieces of twine are placed across the disc they prevent the formation of the necessary partial vacuum and the disc fails to adhere, while if the disc is adherent, the introduction of a finger-nail or the blade of a knife between the disc and the surface to which it is adhering allows air to enter and the hold of the sucker is immediately destroyed.

Further experiments were conducted in order to try to determine the strength of adherence of the sucker. In the first experiment, an Echeneis was allowed to attach itself to the enamel surface of a dish and a hook attached to a spring balance was passed through the gill from one side to the other. By standing on the dish and pulling on the spring balance, the amount of force could be fairly accurately measured, and in the specimen experimented with the fish withstood a vertical pull of more than 30 lb. before the hook tore through the tissues of the body. Further experiments were conducted by allowing the fish to attach itself to an enamel iron tray, the tray being fastened securely by rope to the spring balance. The balance was attached to a stanchion, and the head of the fish was seized in a towel to prevent the fingers from slipping on the skin of the fish. Two examples withstood a vertical pull of 34 and 35 lb. respectively before the sucker was pulled away from the surface.

It seems to me that there is little doubt that the disc acts as a true sucker by the creation of a partial vacuum, while the spines are of use in preventing this sucker from sliding on the surface of attachment. Thus, during life, when the Echeneis attaches itself to some other larger fish, it is owing to the partial vacuum formed that the disc adheres to the surface, while the spines prevent the Echeneis from being swept backwards by the rush as the large fish makes its way through the water.

A further point worth noting is that when the sucker is in action and the Echeneis is attached to any object, all movement of the fish, except that of the mouth and gills that is necessary for respiration, seems to be suspended and inhibited. The fish hangs absolutely motionless, and in the case of a fish that had been well hooked, it was found that by allowing the fish to attach itself to a glass plate it would hang motionless, while the hook and a great part of the fish's jaw was cut out! It appears that the action of the sucker causes inhibition of all movement of the body and tail.

In order to avoid any misapprehension, may I be allowed to add that my experiments were carried out at the suggestion of Dr. Hora, and the above notes, recording the results, were forwarded to him last January.

R. B. SEYMOUR SEWELL

R.I.M.S. *Investigator.*

Transmission of Stimuli in Plants.

AN article appears on the above subject in NATURE of October 25, in which reference is made to Mr. Snow's experiments (Proc. Roy. Soc., Series B, Vol. 96, No. 678) in support of Ricca's theory that conduction of stimulus in Mimosa is brought about by the transpiration-current in the wood carrying a hypothetical stimulating substance. Mr. Snow joins two cut pieces of stem of *Mimosa pudica* by a tube filled with water and applies a flame to the lower half of the stem with the result that the leaves of the upper half of the stem undergo a fall, hence it is concluded that stimulus is conducted across the water-gap. Mr. Snow also finds that the transpiration-current in Mimosa travels at about the same rate as the conducted excitation. I have carried out numerous experiments with this plant relating to the supposed transmission across a water column, taking the precaution that the heated air from the flame did not excite the upper leaves. Other modes of stimulation were also used which were less open to sources of error. In no case did I find any evidence of the transmission of stimulus through the tube filled with water. This is confirmed by the results obtained by Prof. Koketsu last year, who found that when the petiole of Mimosa was cut into two halves, and rejoined by a water-tight tube filled with water, stimulus applied on the distal half was never conducted across the gap. (R. Koketsu, Journal of Department of Agriculture, Kyushu Imperial University, Vol. 1, p. 55, 1923.)

I also applied a chemical stimulant, and made a simultaneous determination of the rate of the transmitted excitation and of the rate of transport of the stimulating substance. The two rates are of very different order, that of the transmission of excitation being at least a hundred times the quicker. The slow transport of a stimulant or of a hormone, and the rapid transmission of excitation, ought not to be confused with each other. I have carried out numerous experiments which prove conclusively that the transpiration-current has nothing to do with the conduction of the excitatory impulse.

In the article referred to above, I find no reference to my earlier researches on the transmission of excitation in Mimosa, some of which were published so far back as eighteen years ago ("Plant Response," 1906, "An Automatic Method for the Investigation of Velocity of Transmission of Excitation in *Mimosa*," Phil. Trans., 204, B, 1913, "Irritability of Plants," 1913, "The Dia-heliotropic attitude of Leaves as determined by Transmitted Nervous Excitation," Proc. Roy. Soc., B, Vol. 93, 1922). These researches proved conclusively that the *conduction is a phenomenon of propagation of protoplasmic excitation*. This was proved by numerous experiments of a crucial character. Among these may be mentioned the characteristic polar effect of a constant current in protoplasmic excitation. I have shown that an excitatory impulse is initiated at the cathode at "make" and at the anode at "break" of the current, the excitatory impulse being afterwards transmitted to a distance. I have shown, moreover, that the interposition of an electrotonic block arrests the excitatory impulse in the conducting tissue of the plant as in the nerve of the animal. The above results have since been fully confirmed by Koketsu. The characteristic effects described above disprove the theory that the transpiration-current is concerned in the conduction of excitation. A full account of my more recent experiments will, I hope, be published shortly.

J. C. BOSE

Bose Institute, Calcutta,
November 20.

An Approximation to the Probability Integral.

REFERRING to Prof. H. C. Plummer's letter on "An Approximation to the Probability Integral," published in NATURE of October 25, the following alternative way of representing the normal error function by simple approximation may be of interest. The original demonstration of this has been given by me in Physical Department Paper No. 8, "A Method of Curve Fitting"

Let us write as follows the equations for the three variables x, y, z.

$$z = \frac{a}{\sigma\sqrt{2\pi}} e^{-x^2/2\sigma^2}, \qquad (1)$$

$$v = \int_0^x z\,dx. \qquad (2)$$

In the above-mentioned paper it is shown that the equation

$$z = k\left(\frac{a^2}{4} - v\right)^{0.8111} \qquad (3)^1$$

gives a very close approximation to the values taken from a Probability Integral Table. The numerical value of k may be computed from

$$k\sigma = \frac{1.2318}{a^{1.6222}} \qquad (4)$$

Now, eliminating z from equations (1) and (3)

$$v = \sqrt{\frac{a^2}{4}} - 10^u, \qquad (5a)$$

$$u = \log_{10}\frac{a^2}{4} - 0.2677\left(\frac{x}{\sigma}\right)^2 \qquad (5b)$$

Putting $a = 1000$, the following Table shows the degree of accuracy of the equations (3), (5), and of Prof. Plummer's formula.

From Prob. Integral Table		From (3)	From (5)	Plummer's
x	y	x	v	y
0.0	398.9	0	400.1	0	0
0.5	352.1	191.5	351.8	189.0	191.5
1.0	242.0	341.3	240.6	339.2	342.0
1.5	129.5	433.2	129.7	433.1	435.1
2.0	54.0	477.3	56.3	478.3	478.8
2.5	17.5	493.8	19.9	494.7	488.4
3.0	4.4	498.6	5.6	499.0	
3.5	0.9	499.8	1.3	499.9	

Prof. Plummer's formula may be used only up to $x/\sigma = \sqrt{6} = 2.449$ (see NATURE of October 25). It is simpler than equation (5), and is to be preferred whenever values of y are quickly wanted for small values of x. However, in practical statistical work, problems may arise requiring one of the variables x, y, z to be determined in terms of one of the other two over the whole of the range of x. For such cases, when great accuracy is not wanted, the above equations may be useful to replace Probability Integral Tables. The variable x may be computed in terms of y from equations (1) and (3).

S. KRICHEWSKY.

Physical Department, Cairo
November 22.

The Word "Scientist" or its Substitute.

I DO not think exception can fairly be taken to the adoption into a living language of any word that (1) contributes to convenient expression and (2) violates no rule or custom in etymology. Contemporary speech has this advantage over a dead language as a vehicle of thought, that it can be adapted to changing circumstance, whether that be effected by modifying the meaning of old vocables or by the addition of new ones. The invention of printing did much to arrest colloquial change and to standardise speech, but a useful measure of elasticity still prevails. Examples in point are the verbs "to burke" and "to boycott," which it would be very inconvenient to discard.

It has been pointed out by correspondents in NATURE that there is plenty of analogy in sound English for the formation of "scientist" from "science". Sir E. Ray Lankester objects to the term because there is no precise definition of science, but surely we all know what is meant by a "man of science," for which term "scientist" seems a neat synonym, standing aptly in antithesis to "sciolist"—one who has a smattering of some branch of knowledge.

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire.

WRITING as a student of the history of words, "scientist" can never become a *permanent* part of any language, for its quantity is "impossible". It has a destructive effect in a sentence, and when spoken the last syllables must be gobbled. "Naturalist" may be gobbled fairly easily; few people notice it, but "scientist" is difficult. So perhaps it scarcely matters whether the word receives or not the approval of the dictionaries, words which we instinctively feel are repulsive drop out of use.

The only possible salvation for the word is for its advocates to introduce the more correct pronunciation "sciéntist," that is, middle syllable accented. Thesist, logist, are alternatives which suggest themselves; the latter would be in conformity with "biology" and the many other "logy's".

REGINALD A. FESSENDEN.

45 Waban Hill Road,
Chestnut Hill, Mass.,
December 15.

The Spectrohelioscope.

I AM very glad to learn from NATURE of November 8, p. 683, that Mr. F. Stanley is also engaged in developing a spectrohelioscope. In my long focus (13 feet) instrument, where the slits are rather narrow and hence close together in order to give sufficient light with the requisite purity, the motion of the spectral line is practically equal to that of the slit for the small displacements from the optical axis involved. Thus it is possible to avoid the use of such deflecting prisms and gearing as Mr. Stanley employs. I have not yet attempted, however, to design a short focus instrument.

A rotating disc with radial slits makes a natural appeal to the instrument designer and I used it for my first (unsuccessful) experiments, made on Mount Wilson with the 30-foot spectroscope of the 60-foot tower telescope many years ago. It will serve very well with a moderate number of slits when there is sufficient light, but the high purity required for observations of the hydrogen flocculi complicates the problem. For example, in order to obtain with a disc the purity and brightness I now command with an oscillating bar (carrying two sets of five slits each), it would be necessary to use about 400 radial slits, each 0.003 inch wide and with errors of spacing less than 0.001 inch. This can, of course, be done, and I shall probably try it, but the simple oscillating bar suggested itself as an easy means of making a rigorous test of the method for the exacting task of observing the hydrogen flocculi against the brilliant disc of the sun.

GEORGE E. HALE.

Pasadena, California,
December 3.

[1] The exponent of equation (3) has been previously given as = 0.7864 and has been recently corrected to 0.81111 by more rigorous methods. Equation (4) has been correspondingly corrected.

The Compton Effect.

APROPOS of the very readable review of the discussion on scattered X-rays at the Toronto meeting of the British Association, published in NATURE of October 25, p 627, we presume your readers may be interested in a bit of new evidence on the reality of the Compton effect, obtained since that meeting.

We have photographed spectra of scattered molybdenum rays, with the tube and scatterer in one room and the spectrograph in another. The walls near the tube and scatterer were lined with lead, and the room was large enough to remove all other substances exposed to the rays to a safe distance. By that we mean a distance such that even if those substances converted all the radiant energy falling on them into tertiary rays, the total quantity of tertiary radiation sent by them to the "scatterer" would be reduced by the inverse square law alone far beyond detection. We built two such sets of apparatus, in different parts of the room, and used them at different times. One was a molybdenum-target tube with a sulphur scatterer The other was another molybdenum-target tube, of a different form, with an aluminum scatterer, using a spectrograph of quite a different design

Both of these sets of apparatus gave spectra like those described previously by Ross (*Phys. Rev.*, Nov. 1923, Proc Nat Acad Sci, July 1924), which had given the first definite proof of the existence of the Compton effect in elements other than carbon These new spectra showed the Compton-theory lines as strong as in the earlier spectra Apparently, therefore, these experiments confirm the calculations described at the Toronto meeting showing that those spectra were quite free from any contamination by box effects, and were due only to the elements to which Ross ascribed them.

D L WEBSTER.
P A ROSS

Stanford University, California, U S A,
December 3

Arsenic in Oysters.

YOUR contributor J. S G in reviewing (NATURE, December 20, p 913) the report of the Ministry of Agriculture and Fisheries on oyster mortality in 1920, and dealing with the finding of 3·7 parts of arsenic per million in oysters from certain beds, comments on the serious questions raised by such a fact. A definite pronouncement is needed as to what constitutes danger As is well known, the Royal Commission on Arsenical Poisoning, in its report in 1903, recommended that no substance used in the preparation of food should contain more than 1/100 grain per lb. This recommendation has been adopted as a standard for years, and many prosecutions have been successful for quantities but little in excess of this Surely the position is now more illogical than ever it was. Is the fishmonger to be prosecuted if his oysters have three parts per million (1/50 grain per lb.), and, if not, why should a grocer be charged if, say, a baking powder—probably not made by himself—contains this amount?

Results of investigation in Sweden show that fish may have an arsenic content up to four parts per million, and my own analyses of fish sold in the London market, recently communicated to the Society of Public Analysts, confirm this figure in respect of certain plaice. The administration of the Sale of Food and Drugs Acts in this respect requires revision.

H. E. COX.

The Laboratory, 11 Billiter Square,
London, E.C.3,
December 24.

Convective Equilibrium.

THERE is a rather important consideration connected with the production of cloud in rising air currents (which does not seem to have received attention) the effect of which is to check uprushes of moist air.

I have often noticed the cumulus clouds over a distant thunderstorm suddenly cease to rise and then disappear Whilst rising, their outlines are clear and sharp As soon as the rise ceases their outlines become indistinct Then a partially transparent veil appears where the cumulus cloud was, and this fades away entirely, leaving the atmosphere clear. Why do cumulus clouds fail to rise so high as one would expect them to?

Warm saturated air near the earth's surface (warmed by proximity to the ground) rises and steadily cools. After the dew point is reached important results follow Condensation takes place and the air is then prevented from falling in temperature so much as it would do if it were dry, and this would accelerate the velocity of the up current if it were not for the presence of the *newly formed cloud particles* The small drops forming the cloud are floating in the air and contributing their quota to its weight Condensation thus tends to check the ascent of the mass When the particles become large enough to descend quickly, as rain or hail, they draw the air down with them and the uprush ceases

The mechanical effect of falling rain, and the great density of a cloud due to the weight of the water particles in it, do not seem to have been generally considered R M DELLEY

Tintagil, Kew Gardens Road,
Kew, Surrey,
December 24

Molecular Dimensions of Celluloid.

THE results of the experiments carried out by the Bureau of Standards, Washington (NATURE, December 13, p 861), are of very great interest, but would be still more valuable if the exact composition of the "celluloid" were known There is often confusion in referring to such words as "celluloid," "celloidin," "collodion" and the like Celluloid, the basis of photographic film, is certainly a manufactured mixture of variable composition, containing among other ingredients a considerable percentage of camphor, the main ingredient being, of course, a soluble cellulose trinitrate, though cellulose acetate is now being increasingly used on account of its non-inflammability. It is, therefore, scarcely correct to speak of the "molecular complex of celluloid" (unless "complex" is intended to cover a mixture of two or more compounds) "Celloidin" is the trade name of a carefully purified and soluble cellulose nitrate, probably approaching to a single chemical substance. Collodion is, of course, a solution of nitrocellulose in acetone, ether-alcohol, or some other organic solvent. HENRY GARNETT

3 Lea Road,
Heaton Moor,
near Stockport,
December 14

ERRATUM.—In NATURE of October 4, p 490, a letter from Prof. Was Shoulejkin on "A New Method of Investigating Sea Waves" is subscribed "Technical High School, Moscow." The work described was carried out at the Physical Institution of the Science Institution of Moscow.

The Theory of Evolution since Darwin.[1]

By Prof. E. W. MACBRIDE, F.R.S.

NO event in the intellectual world has had such a profound influence on the mental outlook of mankind in general as the publication of the "Origin of Species" by Charles Darwin in 1859. A distorted version of the theory embodied in it figured largely in the propaganda that led to the Russian revolution. Nothing could be more interesting to the student of the history of thought than to analyse the ideas and assumptions involved in this theory and to trace their fate in the subsequent course of scientific criticism.

The outlines of Darwin's theory are familiar to all, and the technical terms which he introduced—"natural selection," "the struggle for existence," "the survival of the fittest"—have passed into everyday language. It is to be noted that he termed his theory "Descent with modification," and that the name "evolution" was first applied to it by Herbert Spencer. This is significant, because in Herbert Spencer's mouth, evolution denoted a general theory of everything that was going on in the universe, of which the development of animals and plants formed only a small part. We must emphasise, therefore, the fact that Darwin takes life and the fundamental properties of living things for granted; he does not strive, like Spencer, to explain them in terms of matter and motion.

Founding on what he could observe of the nature of life as he saw it, Darwin strove to argue back to what was the condition of the living world in past times and what are the influences at work in modifying it at the present time. He assumed that animals and plants are continually giving rise to small variations in all directions and that these variations are inheritable. This is the positive idea which is embedded in what is generally called the theory of "natural selection." For "natural selection," the death of the many and the survival of the few, is only the pruning knife and can of itself originate nothing new. These random variations Darwin attributed not to chance but to the environment, which, as Darwin imagined, produced an instability in the hereditary qualities of organisms which are exposed to new conditions. But besides this effect, Darwin asserted that the results of increase in size of organ by use and its diminution in size by disuse were inheritable. He was driven to this assumption by the endeavour to account for the disappearance of unused organs in such cases as that of cave-animals which had lost their eyes. He could not conceive how small decreases in size in organs which were no longer used could give their possessors the victory in the struggle for existence. Darwin imagined, further, that the struggle for a bare existence was in many species accompanied by a struggle to find a mate, a struggle which was undertaken by the male; and he attributed the varied peculiarities of colour, shape, ornaments, and voice which distinguished males from females, to the preference of the female for the most attractive male. The results of this supplementary struggle were termed by Darwin "sexual selection." This part of the theory has not met with general acceptance, and we can therefore leave it out of account.

The difficulties in his theory which Darwin felt most acutely were the beginnings of useful organs from small useless rudiments and the origin of the sterility which usually exists between allied species. The first difficulty has been largely removed by the progress of embryological research, for it has been shown that new organs do not originate from useless rudiments but by the modification of older and simpler organs, but the second difficulty has not been fully solved even to-day. Believing as he did that allied species were only more sharply differentiated local races of the same species, Darwin yet had to admit that local races were mutually fertile, and that allied species when crossed were sterile. He pointed out that sterility could arise between members of the same species as it has done in the case of the primrose, and he imagined that sterility was, so to speak, a by-product of increasing divergence of constitution.

Of course, as Darwin himself pointed out, many naturalists before him had interpreted the likenesses of allied species as evidence of blood relationship, and had even put forward speculations as to the course of evolution; but the weak point in all these theories had been that they did not point to causes now in existence by which evolution could have been brought about. The first effect of Darwin's theory was to convince scientific men, especially naturalists, that evolution really had occurred and that it was in fact still going on. The feature in the theory which secured their assent was "natural selection." It seemed to his contemporaries that Darwin had laid hold of a fact which, when once attention was directed towards it, no one could deny, namely, the death of the many and the survival of the few. It is true that Lamarck had previously relied on natural causes, such as the effects of use and disuse and the production of new habits as the agents in evolution, and I myself believe that he was in great measure right, but the changes of habits in animals which he postulates are phenomena which are slow in their effects and do not constantly occur, and they are not easily observable within the limits of a human life. Moreover, the facts which now give support to Lamarck's views were not known when he wrote, nor even when Darwin wrote, and hence Lamarck failed to produce an effect on contemporary thought at all comparable to that which was effected by Darwin.

Huxley in England and Haeckel in Germany were the great champions of the evolutionary principle against theological opponents. Haeckel[2] made to the theory one great addition which is of far-reaching consequence: it had been dimly perceived by Darwin and is hinted at in the "Origin of Species," but it was first clearly enunciated by Haeckel. In his "General Morphology," first published in 1866, he stated that "Ontogenesis, or the development of the individual, is a short and quick repetition (recapitulation) of phylo-

[1] From a lecture delivered at King's College, University of London, on November 28 for the Board of Studies on the History, Principles, and Methods of Science.

[2] My friend Prof. Dendy has pointed out to me that Haeckel derived his "Law of Biogenetics" from Meckel, who wrote in 1827, but as Meckel was opposed by von Baer, the great comparative embryologist of the day, his views were ignored.

genesis, or the development of the tribe to which it belongs determined by the laws of inheritance and adaptation." This in shortened form, "Ontogeny is a recapitulation of Phylogeny," was called the "Fundamental Law of Biogenetics."

The validity of this law Haeckel sought to establish by numerous examples, and he has been accused, apparently with justice, with misrepresenting some of the facts in order to bring them into conformity with it. He is said to have made four separate drawings of the same embryo and to have labelled them with different names so as to show the identity of the early embryonic form in four different groups This was detected, and together with the wildness of much of Haeckel's speculation tended, especially in Germany, to produce a strong reaction against most of Haeckel's teaching. But in spite of Haeckel's unscrupulous action he was in many respects a far-reaching genius Though some naturalists have affected to disbelieve in the biogenetic law, in practice, in their morphological reasoning all assume its validity Even Haeckel's special theory, namely, the derivation of the higher animals from a single hypothetical hydra-like ancestor, which he called the "gastræa," has received more and more confirmation as embryological research has proceeded

Haeckel never thought that variations could be due to chance, on the contrary, he attributes them all to differences in nutrition Some which we call "directly adaptive," like the effects of use and disuse, which alter the flow of blood to an organ and so change its nutrition, show their effects in a single generation, whilst others which he calls "indirectly adaptive" only make themselves felt in the next or succeeding generations He says that the "superiority of Englishmen is due to their being fed on excellent beef; but the beef results from the cattle being grazed on rich clover pasture. Clover is fertilised by wild bees, but wild bees are decimated by field-mice, which are kept in check by cats Cats are usually kept by old maids, and therefore this peculiarity of unmarried females is the original cause of British pre-eminence."

Huxley, though he contributed immensely to the building up of a scientific zoology on the basis of Darwin's theory, added nothing to the theory itself, but one of his sayings may be quoted as showing his insight into the matter at stake. "We have got our theory of evolution; what we want now is a good theory of evolution." We shall find that practically all subsequent criticisms of what for brevity's sake we may term Darwinism turn on these two questions, namely: (1) What is the nature and cause of variation? (2) Why are species usually mutually sterile?

We have already directed attention to the fact that the development of animals and plants from simpler ancestors was included by Herbert Spencer in his theory of evolution, a theory intended to explain everything that was going on in the universe on the basis of the laws of mass and motion. But Spencer laboured under all the disadvantages which beset those who write treatises on subjects with which they have only a second-hand or superficial acquaintance It is true that in his "Principles of Biology" he sees clearly that the vital point at issue in Darwinism is the origin of variations, and he throws his whole weight on the side of the inheritability of the effects of use and disuse. But his arguments are not convincing, since they always involve a "petitio principii", he never seems to see that a thorough experimental examination of the subject is necessary, but considers that his point is proved by vague plausible suggestions He suggests that animals are made up of "physiological units," and that these units become modified in response to changed conditions and are then passed into the germ-cells and make their effect felt in the next generation. This conception resulted from his comparison of the regeneration of the limb with the self-completion of a broken crystal in its mother liquor, a conception which we now know to be utterly futile and misleading. No doubt Spencer did much to popularise the idea of evolution with the general public, but it is impossible to point to one addition of any scientific importance which he made to the theory of evolution

It is true that Darwin in a later and far too imperfectly known book, "The Variation of Animals and Plants under Domestication," put forward a suggestion somewhat similar to that of the "physiological units" to explain the origin of variation This is the theory of "pangenesis" According to this hypothesis, every part of the body of animal or plant is continually throwing off "gemmules" which are endowed with the power of multiplication and with the capacity, in suitable circumstances, of growing into the likeness of the part from which they came These gemmules are carried from part to part by the circulation, and they accumulate in the germ-cells They become altered in character in accordance with the alteration of the part from which they come, and when sufficient of the altered gemmules have accumulated in the germ-cells, the alteration becomes hereditary. Darwin's gemmules, however, are living units endowed with the characteristic vital properties of growth and reproduction, whereas Spencer's physiological units are merely large organic molecules.

The next important event in the history of the theory of evolution is the advent of Weismann, who in 1885 published his "Essays on Heredity," which were later consolidated into a book termed "The Germ-Plasm" Until his time it had been tacitly assumed that the effects of use and disuse could be inherited, and the only reason for refusing to assign to them the exclusive importance attributed to them by Lamarck was the difficulty which many naturalists felt in explaining some evolutionary changes by the accumulation of the results of efforts on the part of the animals or plants which exhibited them. But Weismann challenged the validity of the whole of the Lamarckian doctrine, and this he did on two grounds first, that the evidence in favour of acquired characters was not sound, and secondly, that on account of the structure of what he calls the "germ-plasm," acquired qualities could not be transmitted. He therefore sought to explain the origin of variations by what I can only term the accidents besetting the ripening of the egg. Since all the father's potencies in heredity are contained in the sperm-head, which is a condensed mass of chromosomes equal in number to those in the ripe and unfertilised egg, the real bearers of hereditary powers must be the chromosomes.

If now we suppose that a single chromosome, which Weismann terms an "idant," nay, even a portion of a chromosome which he calls an "id," is theoretically capable of carrying out the entire development of the species, but that different "ids" would give rise to slightly different types of development and that the actual development of the egg is a compromise between the potencies of the various "ids," we arrive at the Weismannian explanation of variations. If it is mere chance which group of "ids" are thrown out of the nucleus when the number of chromosomes is halved at ripening, then obviously all sorts of different groups may be left in the make-up of the various eggs and various sperm-cells, and these different groups will give rise to different inheritable variations of which natural selection will preserve those best adapted to the circumstances of the animal

But why should the various "ids" differ from one another? To this question an extraordinary answer was given by Weismann When a cell divides, the nucleus divides first and each chromosome gives rise to daughter chromosomes by longitudinal splitting, which then by nourishing themselves at the expense of the protoplasm grow as big as their parent. During this growth, variations in nutrition of the daughters are the causes of variations in their structure which are handed on to their posterity at the next division! So that the very principle which Weismann rejects at the beginning of his hypothesis, he reintroduces in dealing with the chromosomes, namely, external circumstances giving rise to inheritable variation Let us now glance for a moment at the way in which the theory is worked out in detail. The fertilised egg begins its development with a selected group of "ids" derived in equal proportions from the father and the mother; each of these "ids" contains within it the entire potency to bring about the development of the adult form. When the egg-cell divides, the division, though apparently an equal one, is in reality unequal—one daughter retains the "ids" undisturbed, but in another the "ids" have already undergone decomposition and are now represented only by "determinants," each of which has only the potency of causing the development of that part of the body to which this daughter-cell will give rise. As development continues, the determinants suffer further decomposition until at length they are resolved into "biophores," which have only the capacity of conferring on the cell in which they lie the power to become a muscle-cell, a nerve-cell, a gland-cell, etc The descendants of the other daughter-cell of the original two, however, receive unbroken "ids" and eventually give rise to the germ-cells of the next generation Their lineage is called the "germ-track"

On the Weismannian hypothesis, then, the germ-cells are separated from the body at the very beginning of development and are not afterwards influenced by what happens to the body during its growth, and Weismann, with true Teutonic thoroughness, having formed this conception of the structure of animals, declares it be *a priori* impossible that acquired characters, *i.e.* new habits, could affect the germ-cells, since, as he states, he can form no conception of how the change in structure resulting from a changed habit can be represented in the nucleus of the germ-cell. The experiments alleged to prove the inheritance of acquired qualities which were available to Weismann were supposed examples of the hereditary transmission of mutilations; these he sought to explain away, and he cut off the tails of mice and bred from these maimed animals, and showed that the offspring did possess well-developed tails.

Weismann's doctrines obtained wide acceptance, and were regarded as finally disproving the environmental origin of variations, and the position remained practically unchanged until the beginning of the twentieth century.

We may now pause for a moment to take up the question of the sterility between species. In 1897, Romanes, a Cambridge man who had migrated to Oxford, published a book entitled "Darwin, and after Darwin." In this book he considers the question of how two divergent species could have arisen from one, and he points out that it is inconceivable that this could have happened by the natural selection of accidental variations, unless two portions of the original species had become isolated from one another so that cross-breeding was prevented. Romanes puts forward the idea that owing to accident (*i.e.* unknown causes) physiological variations occurred, so that two portions of the same stock became mutually sterile. He thinks that geographical isolation is insufficient to account for the appearance of sterility, because species occupying adjacent territories are often mutually sterile, and he cannot conceive how what seem to him slight differences in climate can effect so great a change as sterility, but as to the causes of the appearances of this "physiological isolation" he gives no hint whatever. No further light was thrown on this subject until the last year or two, when Goldschmidt took up the question of the mutual fertility of local races of the same species when crossed. He showed in the case of the gipsy moth that when two races from widely separated localities are crossed, sterile intersexes are often produced which render the continued propagation of the mixed race difficult. His results therefore support Darwin's hypotheses of sterility as a by-product of increasing divergence of constitution.

The twentieth century began with two events of decisive importance for the theory of evolution; namely, the rediscovery of Mendel's researches by Correns in 1900 and the publication by Johannsen in 1903 of a paper entitled "The Bearing of Pure Lines on the Theory of Inheritance." Mendel's researches, which were carried out at the same time as Darwin's work and published soon after the publication of the "Origin of Species," appeared in local journals of too limited circulation, and attracted no notice from the general scientific world. They had in Mendel's mind no relevancy to the formation of species whatsoever, but were concerned only in discovering the laws governing the distribution of paternal and maternal characters amongst hybrid offspring. Mendel in his experiments always chose varieties sharply separated from one another by definite clearly-cut characters. The rediscovery of Mendel's work gave a great impetus to the carrying out of experiments in crossing all kinds of variants from the normal with the type. In these experiments Bateson in England and Morgan in the United States took leading parts, and it was soon dis-

covered that those sudden deviations from the normal which turn up without assignable cause in most breeds of domestic animals and varieties of cultivated plants obey the Mendelian rules when crossed with the types Johannsen's results proved the non-inheritability in the case of beans of those small random deviations from the normal in all directions on which Darwin had laid such stress, and these results were independently confirmed by Jennings, who worked on Protozoa, and by Agar, who studied small Crustacea (1912).

In consequence of these discoveries, biological opinion veered round in favour of regarding the conspicuous aberrations commonly known as sports as the raw material on which natural selection had worked Darwin, it is true, had considered the question of whether sports might not be the starting-point of new species, and had decided that they could not be so on account of the rarity of their occurrence. He thought that the chance of such a sport mating with its like, even if highly successful in the struggle for existence, was infinitesimal, and that if it did not mate with its like its characters would be "swamped by intercrossing" But if the deviation were in a direction favoured by natural selection, it might be assumed that it would make itself felt in lesser degree even when its orginal possessor crossed with the type, and the first generation descendants might still survive on account of its lessened manifestation Many have claimed that this argument is strongly reinforced by the discovery of the laws of Mendelism. For if the deviation behaved as a dominant when crossed with the type, all the first generation of the descendants of such a cross would show it in as strong a manner as its orginal possessor; and even if it were recessive it would appear in undiminished strength amongst one-fourth of the second filial generation. The real objection to regarding sports as the initiators of new species lies deeper An animal does not survive on account of one organ. In its growth from the egg to the adult, it runs the gauntlet of many dangers, and a strong development of some one organ might determine its survival at one period of its existence, but if the deviation occurs very rarely the chances against that particular animal reaching the critical stage at all are enormous.

De Vries, the director of the botanical gardens at Amsterdam, carried out between the years 1886 and 1899 a series of cultures of the garden plant *Œnothera Lamarckiana*, commonly known as the evening primrose He showed that every year a number of sports turned up, usually about half a dozen in 10,000 specimens, sometimes as many as three in a hundred, and that this sports usually, though not always, bred true when crossed with their like De Vries called these sports "mutations," and imagined that he had surprised a species in a "fit of mutation," and that new species were not produced by a slow process of differentiation but by sudden jumps, so that they began their existence complete in all their details, as Minerva sprang from the head of Jove. The De Vriesian doctrine joined with Mendelism, and became the dominant doctrine of evolution and heredity for most of the first quarter of the twentieth century, and probably counts amongst its adherents a larger number of biologists than any other doctrine at the present time. It was first seriously put forward by Bateson in 1894 in a book entitled "Materials for the Study of Variation," in which he figured and recorded a large number of examples of monstrous deviations from the normal, and laid down two doctrines, one of which is undeniably true, whilst the second is really the De Vriesian theory. The first was "variation is evolution", the second, the "discontinuity of species is due to the discontinuity of variation"

The De Vriesian view has reached its climax in a book termed "Age and Area" by Dr Willis, a distinguished botanist. This book was published two years ago, in it Dr Willis supports the idea that species originate in sudden inexplicable jumps which occur only rarely. This idea is difficult to distinguish from the pre-Darwinian doctrine of special creation No wonder that Haeckel, who lived long enough to encounter this view in its early presentation by Bateson, said "If views like this are to be accepted, it would be better to return to Moses at once"

(To be continued.)

Biographical Byways.

By Sir ARTHUR SCHUSTER, F.R.S.

INTRODUCTION.

THERE are things seldom referred to in obituary notices and sometimes omitted even in more ambitious biographies. They tell the tale of peculiarities or weaknesses, which the writer fears may detract from the merits of the man he has set out to praise. The biographer believes, with some show of justice, that his main object is to give a record of work accomplished and not a psychological analysis of character. But eccentricities, or even decided failings, form part of a man's personality. The extent to which his teaching carries conviction and affects the scientific outlook of his time, depend as much on his personal attributes as on the merits of his researches. We destroy the balance of a just valuation, if we ignore those shades of character or temperament which act as handicaps to the full fruition of his work.

It has been my good fortune to be acquainted personally with many of the men who laid the foundations of the science of the nineteenth century, and I have retained a vivid memory of such intercourse as I had with them In writing down some of my recollections I have tried to outline personalities in a sympathetic spirit. If human frailties are sometimes exposed, I hope that the limits of allowable candour have never been transgressed, and that, apart from the personal factor, the incidents related may be found to contain some substantial contributions to the history of science during the middle period of last century

1. URBAIN JEAN JOSEPH LEVERRIER (1811–1877).

Towards the end of December 1874, or nearly in the year 1875, I received an invitation from the Royal Society to take part in an expedition which was being

organised to observe the total solar eclipse of April 1875 in Siam. Norman Lockyer was expected to act as leader of the expedition, which was to start in February; the time for preparation was therefore short. Ultimately Lockyer, who was then acting as secretary to the Royal Commission on Science Teaching presided over by the Duke of Devonshire, did not obtain the leave of absence he had expected, and I was put in charge. I had never had any experience in mounting or dismounting astronomical instruments, or indeed in using them, and one of the appliances on which we depended—a large siderostat—was under construction and not expected to be ready before the eve of our departure. It was essential that I should get some knowledge of the instrument, and more especially of the process of silvering the mirror, which was to be a foot in diameter. A similar siderostat was in use at the Paris Observatory, where M. Adolphe Martin had found a simple and convenient method of silvering large surfaces of glass. I was therefore sent to Paris, the consent of Leverrier, the famous director of the Observatory, having been obtained.

I first called on Cornu to ask advice on some optical questions that had arisen and, needless to say, I met with a most friendly reception both from him and other scientific men, notably Jamin. When Cornu heard that I was to call on Leverrier, he shook his head and said: "Je ne sais pas si M. Leverrier est l'homme le plus détestable à Paris, mais je sais que c'est l'homme le plus détesté." This was not encouraging, and it was in fear and trembling that I entered the Observatory.

I was received by one of the assistant observers, C. Wolf, who remarked with a look full of sympathy. "You will find M. Leverrier in a very bad temper: he has just returned from a funeral." I was then barely twenty-three years old, and naturally looked upon Leverrier (who was then sixty-four) as one of the formidable veterans of science. I was ushered into the "Presence," received with a searching look and the abrupt question: "Qui êtes-vous et que voulez-vous ici?" I mildly answered that I understood Mr. Lockyer had written to explain the purpose of my visit. "So he has," said Leverrier, "but I want to hear it from you." After I had replied to the best of my ability, I was dismissed with the remark: "I have already given instructions that every assistance should be given you."

I spent an interesting and instructive week practising Martin's silvering process, which has the great advantage that the surface comes out polished, except for a thin veil which is easily removed without appreciable friction. When it was time to return home, I suggested to M. Wolf that it might be sufficient for me to write a letter of thanks to Leverrier without troubling him with a personal call. But Wolf would not hear of this, and I was shown again into the "lion's den." Leverrier was sitting at his desk, and by his side stood a trembling young assistant to whom he continued to speak, taking no notice of me. I listened to a conversation of which I remember the main points without pretending to literal accuracy.

LEVERRIER. And so you tell me, that after trying for a whole week you have not yet found the mistake in your calculations?

ASSISTANT. No.

LEVERRIER. You have, of course, applied the correction for . . . (I did not catch the details).

ASSISTANT. Yes.

LEVERRIER. Did you apply it with a plus or a minus sign?

ASSISTANT. Plus.

LEVERRIER. It ought to be minus. That is your mistake. Go and correct your calculations.

After the assistant had left the room, Leverrier chuckled. "I knew all along," he said to me, "what his mistake was, but I wanted to see whether he could find it out by himself"; and to my great surprise he continued, "come and have a walk round the garden." All traces of peevishness and severity had disappeared, and for half an hour or more he became a most interesting and encouraging talker. A new reflecting telescope was just being erected in the grounds of the Observatory, and he explained the uses to which it might be put, inviting me, whenever I felt inclined, to come and work with it.

He then began to speak on a subject on which he evidently felt very strongly. Great preparations had been made in the previous year, and much money spent, on fitting out expeditions to observe the transit of Venus, which had just taken place on December 8, 1874. The French Government had followed the example of other countries, but against Leverrier's advice. It was, of course, well known to astronomers that he preferred other methods of determining the solar parallax, but the Government would not listen to his advice. "Que voulez-vous?"—France had recently been defeated in war, and if she did not share in international work, the Government was afraid that its action might be misinterpreted and believed to be due to sulkiness or want of funds. But Leverrier strongly expressed his opinion that the money was all wasted, and that neither this nor the subsequent transit of 1882 would add anything of value to our knowledge. In this he proved to be perfectly right.

2 JOHN PRESCOTT JOULE (1818–1889).

I once asked Joule what he felt like when he heard that one of his papers was rejected by the Royal Society. "I was not surprised," he answered, "I could imagine these gentlemen in London sitting round a table and saying to each other: 'What good can come out of a town where they dine in the middle of the day.'"

There are some interesting and somewhat puzzling circumstances connected with the fate of that paper, which was communicated to the Royal Society by one of its secretaries, Peter Mark Roget, on October 16, 1840. Under the title "On the Production of Heat by Voltaic Electricity," it contained the account of an experimental investigation which had led Joule to formulate his all-important law, that the heat generated in a conductor by an electric current is proportional to the product of the resistance and the square of the current. The paper was read on December 17, and in due course a short abstract appeared in the Proceedings which gave the final result arrived at, and hence secured Joule's priority. It is, therefore, not quite correct to say that the paper was rejected. The difficulty arose in connexion with its publication *in extenso*. The paper was short—it would not have taken up more than four or five pages in the Proceedings—and it was perhaps

considered that such far-reaching results could not be proved by the comparatively few experiments conducted by Joule. Criticisms were also made on the ground that previous investigations on the same subject were not mentioned On March 11, 1841, the communication was committed to the Archives.

A paper carrying the title "On the Heat evolved by Metallic Conductors of Electricity and in the Cells of a Battery during Electrolysis" shortly afterwards appeared in the *Philosophical Magazine*. It bears the date March 25, 1841, and its introductory paragraph concludes with the sentence:

> "I hope therefore that the results of my careful investigation on the heat produced by voltaic action are of sufficient interest to justify me in laying them before the Royal Society."

This remark has naturally led to the belief (definitely expressed by Osborne Reynolds in his extensive memoir on Joule published by the Manchester Literary and Philosophical Society) that the paper, as printed in the *Philosophical Magazine*, is the one declined by the Royal Society. This, however, is not the case. The difference in the title is significant. The Royal Society paper deals with solid conductors, covering only the ground which in the *Philosophical Magazine* appears as "Chapter 1," and is there followed by a second chapter, twice as long, dealing with electrolysis and adding considerably to the range and importance of the results Even in the first part the two papers are not identical, only a few short paragraphs being unaltered though it must be admitted that the alterations are not material. It is not at all certain whether the complete paper as it appeared in the *Philosophical Magazine* would have been declined by the Royal Society, but it is perplexing that the reference to the Royal Society has been left standing in the altered and extended paper.

We cannot suppose that Joule deliberately wished to convey a wrong impression, and only one explanation seems to me to offer itself. It may be surmised that some correspondence took place in the three months between the date at which the paper was read and that at which it was committed to the Archives On being informed of the objections raised, Joule may have prepared a more complete account to be substituted for the paper originally submitted; but the Royal Society having finally declined to print the original paper *in extenso*, he was quite likely to forward the amplified version to the *Philosophical Magazine*, the reference to the Society in the opening paragraph being left standing by an oversight.

It is not my desire to acquit the Royal Society of all blame, but mitigating circumstances might be urged. Joule's experiments no doubt appear conclusive to us, but the very simplicity of his experimental arrangements, and the comparatively few numerical results given, may have raised doubts which were perhaps excusable. The heat generated was determined by the rise of temperature of a measured quantity of water in which a coil of uncovered wire was inserted, and no cooling correction was applied. Though Joule gave good reasons why these simplifications did not affect the result, such cavalier treatment of the minor sources of error may have shocked the academically-trained mind as showing want of respect for the dignity of the problem It is seldom that referees can rise to the standard of Stokes, who, in reporting on a communication by an eminent man of science possessing great intellectual powers not always assisted by clearness of expression, gave his judgment as follows:—"The first part of the paper I can understand but do not agree with, the second part I cannot understand, but as the results arrived at may be important I recommend that the paper be published in the Philosophical Transactions"

Joule's later work is so intimately connected with the determination of the mechanical equivalent of heat, that the importance of his investigations in other domains is apt to be overlooked. The two volumes of his published researches show that he was by no means a specialist, but only those who knew him personally are aware of the extent of his knowledge and broadness of interests ranging over nearly all branches of physics. He was a pupil of Dalton, who had refused to instruct him in chemistry before he had learned the elements of mathematics. It was perhaps in recollection of his first teacher of science that Joule once remarked to Balfour Stewart "If I were a young man I would concentrate my attention on atomic weights" When I first became acquainted with Joule, he was a little more than sixty years of age and in full vigour The meetings of the Manchester Literary and Philosophical Society in those days will always remain in the memory of those who were fortunate enough to attend them It was the custom then, and I believe is still, to devote the first half-hour to a discussion on any subject brought forward by some member, spontaneously or at the invitation of the president A regular attendant, Joule was at his best on these occasions He also made his presence felt at the council meetings as a confirmed conservative opposed to all changes His health began to fail about 1882, but in November 1885 he dined at my house to meet the late Lord Rayleigh, who had come to Manchester on purpose to make his acquaintance. "I believe I have done a few little things but nothing to make a fuss about," he said, shortly before his mental powers began to fail

After Joule's death, I was asked by his family to examine his apparatus and instruments—mostly constructed by his own hands—and I was fortunate to rescue his historical thermometers, which were lying covered with dust in an old stable attached to his residence I was thus enabled to determine the difference between the scale value of the thermometer used by Joule and that of the standard of the Bureau international des Poids et Mesures. It appeared in the investigation that the glass of Joule's thermometers is more suitable to its purpose than the glass afterwards employed in England. The depression of the zero after being raised to a definite temperature is much smaller and more nearly approaches that of the hard glass used by French makers. These thermometers were presented by Joule's son to the Manchester Literary and Philosophical Society: most of the remainder of Joule's apparatus is preserved in the Physical Laboratories of the University of Manchester

Current Topics and Events.

WE are glad to see that noteworthy recognition is accorded to science in the New Year honours list which was issued last week The appointment of Sir James G. Frazer and of Sir Ernest Rutherford to the Order of Merit, an order which was "designed as a special distinction for eminent men and women" and is limited to twenty-four members, will give particular pleasure to scientific workers everywhere Included among the honours are also the following — *Knights*, Prof John Adams, Professor of Education, University of London, 1902-1922, Prof. R H. Biffen, Professor of Agricultural Botany, Cambridge University, Mr G R Clarke, Director-General, Posts and Telegraphs, India, Dr Hari Sing Gour, Vice-Chancellor, Delhi University, Mr W. B Hardy, Secretary of the Royal Society, Prof F Gowland Hopkins, Professor of Bio-Chemistry, University of Cambridge, Principal J C Irvine, Principal and Vice-Chancellor of the University of St Andrews, Mr F Truby King, Director of the Child Welfare Division of the Department of Health, Dominion of New Zealand, Dr. T. M Legge, Senior Medical Inspector of Factories, Mr B Longbottom, Chairman, British Electrical and Allied Manufacturers' Association, Maj.-Gen R C Macwatt, Director-General, Indian Medical Service, Mr F W Petter, President, British Engineers' Association, Dr H J Waring, Senior Surgeon, St Bartholomew's Hospital, Vice-President, Royal College of Surgeons, Vice-Chancellor of the University of London, 1922–1924 *C.I.E*: Mr H G Billson, Chief Conservator of Forests, and Member of the Legislative Council, United Provinces, India *D B E* (*Civil Division*) Miss L B Aldrich-Blake, Dean of the London School of Medicine for Women

AMONG the mechanical inventions which revolutionised the cotton industry was the cotton gin of Eli Whitney, whose death took place on January 8, 1825—a hundred years ago The flying shuttle of Kay, the spinning jenny, the water frame and the mule of Hargreaves, Arkwright and Crompton, together with the power loom of Cartwright, increased enormously the rate of spinning and weaving, but the cleaning of the cotton fibre from the seed was still largely done by hand. Whitney's great invention was made in 1792, and in about ten years the export of cotton from the United States rose from less than 200,000 pounds to more than 40,000,000 pounds per annum. The essential parts of Whitney's machine consisted of a grid on to which the seeds were fed, a revolving wooden cylinder studded with wire teeth which tore the fibre from the seed, and a revolving brush which in turn removed the fibre from the wires One such machine would do the work of 50 men engaged in hand-picking. Whitney was born in 1765—the same year as Fulton—and was the son of a farmer of Westboro, Massachusetts. He worked as an artisan, made money by teaching, and in 1792 graduated from Yale When about to take up a post as tutor, a chance conversation led to his tackling the problem of cotton cleaning. His gin soon came into use and he had to establish his claims by much litigation. Later, he founded a factory at New Haven for the manufacture of fire-arms and was the pioneer among Americans in the modern methods of making large numbers of interchangeable parts He died at New Haven, leaving a part of his fortune to Yale for the purchase of books on physical and mechanical science

THE year 1924 was a year of notable centenaries, but one of scientific interest seems to have been overlooked, namely, that of the establishment of the first physiological laboratory in Europe The man who opened this laboratory in the year 1824 was Johannes Evangelista Purkinje, at that time professor of physiology and pathology at the University of Breslau It has been suggested that it was through Goethe's influence that Purkinje was appointed to this chair, for the author of "Faust" reckoned him as one of his friends, their common interest being in subjective visual phenomena. The reception given by the Prussians to the Bohemian Purkinje was far from cordial, but by his amiability and scientific gifts he lived down all opposition. The laboratory of 1824 was not housed in any building belonging to the University but in the professor's private dwelling. Doubtless the establishment of this first of European physiological laboratories attracted no attention from the contemporary journalists, but when we reflect on the immense benefits which have accrued to medical science from the findings in the laboratories of practical physiology—insulin being one of the latest—all men of science will like to remember that it is just a few days more than one hundred years ago that the academic pursuit of that subject was inaugurated So far as we can gather, the instruction in Purkinje's laboratory was chiefly in histology, a subject which the anatomists willingly allowed the physiologists to teach for the next century It is only now that that portion of the physiologists' burden is being cast, where it belongs, upon the shoulders of the morphologists.

A WRITER who signs himself "Poetarum Minimus" enters a plea in the *Scientific Worker* for December for the exercise of poetic expression in scientific fields, and as an example he submits a contribution having for its theme the evolution of stars from "tenuous mists" up to maturity and down to decay. Thus,

A hundred million million years they scatter largesse of their rays
They spend their substance royally throughout the measure of their days.

The verses from which these lines are taken have commendable dignity and sound, and they are reminiscent of the style of Erasmus Darwin, who essayed similarly to express views of the stellar universe current in his time in the sonnet, "Roll on ye stars, exalt in youthful prime." Tennyson surpassed all other poets in the application of scientific truth to poetic purpose, and his astronomical allusions are particularly fine, as, for example, in "This world was once a fluid haze of light," and "Regions of lucid matter, taking form: Brushes of fire, hazy gleams."

Several years ago the geological course of events, from "Nebula to Man," was described in verse in a sumptuous quarto volume by the late Mr. Henry Knipe, and Mr. Alfred Noyes has given us his beautiful epic, "The Torch-bearers," which is on a much higher plane. Poetry, however, is something more than accurate description in verse form It should, of course, have a certain beauty of sound when spoken, but its main function is the creation of stimulating thoughts which appeal to the human heart rather than to the intellect. While, therefore, we may believe that the wonders of modern science furnish rich material upon which poetic imagination may be worthily exercised, we cannot forget that emotion is independent of knowledge, and that, as Coleridge said, science seeks to know and communicate truth—acceptable or not—but the chief purpose of poetry is to give pleasure The difference is aptly expressed by Sir William Watson in one of his epigrams, thus.

Science and Art, compeers in glory,
Boast each a haunt divine
"My place is in God's laboratory,"
"And in His garden mine"

A NEW Research Institute for the improvement of crops, at which special attention will be paid to cotton and to the fundamental problems underlying the production of this crop in India, was formally inaugurated at Indore in Central India on November 24 last. The foundation of this new Institute has been rendered possible by the provision of a valuable site of 300 acres by the Indore Durbar, by a grant of two lakhs of rupees (about 15,000*l*.) for capital expenditure by the Indian Central Cotton Committee, and by an annual contribution of 120,800 rupees a year (a little more than 9000*l*.) for current expenses in addition to the income derived from the land at the disposal of the Institute This annual grant has been provided jointly by the Indian Central Cotton Committee and by seven of the Central India States (Indore, Dhar, Jaora, Datia, Rutlam, Dewas Senior Branch, Narsingharh and Sitamau). The control of the Institute has been vested in a governing body of six members with the agent to the Governor-General in Central India as president. Three members of the board of governors are nominated by the Indian Central Cotton Committee, one by Indore Durbar, and two by the rest of the contributing States. The Director of the Institute will act as agricultural adviser to the States, and will in this way come in direct touch with the Malwa plateau, one of the most important cotton tracts in India.

THE experimental area which will be at the disposal of the new Research Institute, has been leased by the Indore Durbar to the Institute for 99 years at a nominal rent of 2*o*l. a year; it embraces all the types of black cotton soil met with in India, and is very favourably situated for research work on crops. It is close to the city of Indore, now rapidly growing in importance as a commercial, manufacturing, and educational centre, and to the cotton mills. The maintenance of an up-to-date library on crop-production and the training of post-graduate students, selected by the Indian Central Cotton Committee, will be features of the Institute. Mr Albert Howard (formerly Imperial Economic Botanist at the Agricultural Research Institute, Pusa) has been appointed Director of the Institute and agricultural adviser to States in Central India, and Mrs Howard (formerly second Imperial Economic Botanist at Pusa) will be employed as physiological botanist at Indore

ON Tuesday, January 6, Sir Oliver Lodge gave the first of his series of seven fortnightly talks on "The Ether of Space and its Functions," under the auspices of the British Broadcasting Company at 2LO, which was relaid to many stations in the British Isles, and also to the longer wave high-power station 5XX at Chelmsford The first talk was entitled "First Notions about the Ether How Matter is held together, and how we see it" After describing the functions and uses of the ether, Sir Oliver went on to explain that matter was discontinuous, consisting of isolated particles not in contact, and was only held together by cohesive forces existing in the ether He supposed that if we could magnify a piece of matter to an impossible extent, it would have an appearance something like the midnight sky, where the separated pieces of matter are similarly held together or united into systems by the force of gravitation—which also is a function of the ether So that the ether is a great unifying entity, without which there would be no cosmos, but chaos. Sir Oliver concluded his first talk thus "You cannot imagine empty space being thrown into vibration; there must be something in space which vibrates, and that 'something' extends to the furthest visible object, and constitutes a unifying and connecting mechanism, through which all our information is obtained . . We have as yet very little acquaintance with the universe, sometimes we seem to know a great deal, at other times we realise that we hardly know anything The mystery of it all escapes us, and the possibilities of it are beyond our conception many of them we could not apprehend if they were explained to us, we have not the terms or ideas to understand them Meanwhile we grope along as best we can, and do our daily work with a keen expectation of the future, and he is wisest who denies least of the mystery which surrounds us and the possibilities ahead. To assert, requires knowledge, to deny, requires much more knowledge Let us be satisfied with positive knowledge so far as it has been vouchsafed to us, and leave negations to the self-sufficing and the omniscient. We can deny the self-contradictory and the absurd, but in the unknown and the mysterious, denials have no legitimate place: our business is carefully and cautiously to ascertain what is. We are surrounded by infinity, infinities of various kinds; and the wealth of existence is such as to justify a faith in our highest conceptions, a hope in the possibilities which lie before us, and a charity which enables us to do our daily work and to love our fellow men."

GREENWICH weather observations, which give approximately the average conditions over England,

show that 1924 was generally wet and unseasonable The winter months were mostly mild, while the summer months were mostly cool, and all months were wet with the exception of February, March, and August The mean temperature for the year 1924 was 50° 6 F., which is 0° 5 F in excess of the normal The warmest month was July, with the mean temperature 63°, which is 0° 5 below the normal; the coldest month was February, with the mean temperature 37° 3, being 2° 5 below the normal December was 3° 5 warmer than the average, and there were only three nights, December 9-11, with frost in the season June, July, and August were the only months with a temperature of 80° or above, the highest reading being 89° on July 12 The lowest temperature during the year was 21° on February 15 Rain fell on 168 days, yielding a total of 31 inches, which is 7 5 inches more than the average for thirty-five years The wettest month was July with 4 20 inches, which is 2 inches more than the normal The driest month was February with 0 65 inch, and this was followed closely by March with 0 69 inch, the deficiency for the two months combined being 2 inches 1924 is the wettest year since 1903, when the annual measurement was 35 54 inches In the dry year of 1921 the total rainfall at Greenwich was only 12 50 inches, in 1923, a normal year, the measured rain was 23 86 inches Sunshine was generally deficient, the only months with an excess of sunshine being January, March, July, and December Records of temperature and rainfall for London now extend over about the last 200 years, but careful examination of these fails to give any cycle or periodicity which can help in the prognostication of the weather for a coming year or season; 1925 has started with exceptionally wet and boisterous conditions

ONE of the recommendations made last year by the Departmental Committee on the Fertilisers and Feeding Stuffs Act, 1906 [Cmd 2125], was the appointment of a committee to consider the articles to which revised legislation should apply This advisory committee, which has power to co-opt, has now been constituted as follows Lord Clinton (chairman), Mr E. G Haygarth Brown, Dr Charles Crowther, Mr J Garton, Mr C W. Higgs, Mr Arthur Holgate, Mr. Thomas Kyle, Mr. Alexander Main, Lieut.-Col. R L Norrington, Mr. J W Pearson, Mr R R Robbins, Sir E J Russell, Mr John Speir, Mr. George Stubbs, Dr J F Tocher, Prof T. B. Wood, and Mr H. J Johns, of the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S W 1 (secretary) According to the terms of reference, the committee is to draw up schedules prescribing the fertilisers and feeding stuffs to which the proposed legislation on the lines of the Report of the Departmental Committee on the Fertilisers and Feeding Stuffs Act, 1906, should apply, and methods of defining and stating the constituents and the "worthless" and "deleterious" commodities are to be considered

AN interesting new departure in tourist travel is the motor tour across the western Sahara to Timbuctoo Citroën Cars, Limited, the organisers of the tour, have sent us an itinerary of the route. The cars leave Colomb-Bechar, the railway head of the Algerian railway, and pass by Igli and Beni-Abbes to Adrar, the centre of the Tuat region. Thence they pass by Taouriot and strike almost due south, reaching the Niger at Burem. From Burem the traveller can continue in cars to Gao or Niamey, with the alternative of going by motor boat to Kabara and car to Timbuctoo. From Colomb-Bechar to Timbuctoo by this route is 1700 miles, and the time occupied is eight days Timbuctoo is thus brought within twelve days of London, and there is a trans-Sahara service twice weekly. Modern hotels have been constructed at Colomb-Bechar, Beni-Abbes, Adrar and Timbuctoo, while at other stopping-places the company maintains camps It is of interest to note that this motor service to Timbuctoo has been instituted within a year of the centenary of the first European traveller entering what was then the mysterious city

MR MURRAY MACGREGOR, district geologist, has been appointed assistant director of the Geological Survey in Scotland in succession to Dr Walcot Gibson

IN connexion with the Liverpool Section of the Society of Chemical Industry, Sir Max Muspratt, Bart., will deliver a Hurter Memorial lecture in the chemistry lecture theatre of the University of Liverpool on Friday, January 16, at 8 o'clock, on "Chemistry and Civilisation"

PROF G T MORGAN, professor of chemistry in the University of Birmingham, has been appointed Superintendent of the new Chemical Research Laboratory of the Department of Scientific and Industrial Research at Teddington Prof Morgan was awarded the Research Medal of the Worshipful Company of Dyers in 1922 for his work on the co-ordination theory of valency in relation to adjective dyeing, and he is the author of numerous original papers in various branches of chemistry published by the Chemical Society, Society of Chemical Industry, and other societies

APPLICATIONS are invited for some junior assistantships at the National Physical Laboratory, Teddington Candidates must possess a good honours degree or equivalent qualification in physics, engineering or electrical engineering, and preferably with some experience in research Application forms can be obtained from the director of the laboratory. They must be returned to him by, at latest, January 17.

ACCORDING to the New York correspondent of the *Times*, the trustees of the Metropolitan Museum of Art have announced the gift to that institution by Mr John D. Rockefeller, junior, of 16,000 shares in the Standard Oil Company of California. These shares are worth approximately 200,000*l*. The gift is made unconditionally, but the donor suggests in his letter to the trustees that it should be added to the endowment fund.

ON Tuesday next, January 13, at a quarter past five, Prof. A. Fowler will begin a course of two lectures at the Royal Institution on the analysis of spectra,

and on Thursday at the same hour Mr Julian Huxley will deliver the first of two lectures on the courtship of animals and its biological bearings The Friday evening discourse on January 16 at 9 o clock will be delivered by Sir William Bragg on the investigation of the properties of thin films by means of X rays and on January 23 by Dr A W Crossley on science and the cotton industry

THE third meeting of the Society for Experimental Biology was held at Cambridge on December 19 and 20 the different sessions being held in the Schools of Zoology and Physiology Members were entertained at lunch in Caius College by Prof J Stanley Gardiner and a dinner was held in Christ s College The programme included a paper by Prof J Barcroft on Hæmoglobin as an Example of the Evolution of a Chemical Mechanism a discussion by Dr H H Dale on The Nature of the Active Substances in the Posterior Lobe of the Pituitary Gland and a symposium on The Rôle of Electrolytes in the Organism in which Messrs A J Clark J Gray and J B S Haldane took part A number of other papers of interest were presented Fifteen new members were elected

SIR NAPIER SHAW has published privately a Kalendar for 1925 arranged in weeks showing the seasons and the international days for observation of the upper air This is followed by a detailed list of the daily observations of solar and terrestrial radiation made in England during 1924 For each day of the year there is shown the sun s declination the measurement of solar intensity at Kew Observatory between 11h 30m and 12h 30m the observations at South Kensington and Rothamsted of the maximum intensity of radiation from sun and sky and of the total radiation during the day upon a horizontal surface and measurements of incoming and outgoing long wave radiation made at Benson on cloudless evenings These observations are given in weeks with the unusual but convenient arrangement of giving on each page two weeks which are separated by an interval of six months The addition and subtraction of observations separated by six months gives the even and odd harmonics of the radiation curve separately The Kalendar thus contains in readily accessible form much information of great value to meteorologists and others interested in solar and terrestrial radiation

Two books of ethnological interest are announced for publication by Messrs Seeley Service and Co Ltd namely The Menace of Colour by Prof J W Gregory dealing with many of the interracial problems of the day and pointing out the dangers of the rising tide of colour and how they may be met or avoided and Vanishing Tribes of Kenya by Major Orde Browne Senior Commissioner of Tanganyika a record of the habits and customs of the tribes inhabiting the slopes of Mount Kenya

Our Astronomical Column

THE ABSORPTION OF LIGHT IN OPEN STAR CLUSTERS —Dr P ten Bruggencate in the *Zeitschrift für Physik*, October 31 describes an investigation of the colour indices of stars of the open clusters N G C 1647 of Præsepe and of the Hyades and deduces that these clusters consist almost entirely of dwarf stars as is to be expected on the assumption that they have developed from globular clusters and are of great age Colour brightness diagrams were prepared in which the catalogued stars were plotted and with certain assumptions as to the value of the parallax graphs corresponding to the stars of the general stellar system as determined at the Mount Wilson Observatory and described by Seares were drawn on the same diagrams It was found that in neither case did the stars of the cluster agree with the graph This was also true of the colour brightness diagram of the Pleiades which has already been described by the author

In the case of N G C 1647 an analysis of the diagram leads to the conclusion that the abnormal distribution of the stars in it is due partly to the assumed parallax being too large and partly to absorption due to extensions of the dark nebulosity in Taurus which lies between the cluster and the earth In the case of the two other clusters and of the Pleiades there is general absorption due to nebulosity inside the clusters The Pleiades form a younger cluster than the others which contains a number of A and F stars, and the nebulosity in it is bright and connected with the bright stars being formed from material recently given off by these stars, which are in an unstable state of development In Præsepe and the Hyades the clusters are older and the internal nebulosity has become dark

No nebulosity is found in globular clusters which are relatively young the stars not having reached the stage of development mentioned above the first sign of instability in these clusters is the occurrence of variable stars These and the super giants develop to O type stars and planetary nebulæ, and it is to be expected that the remains of these nebulæ will be found in old star groups or open clusters

OBSERVATIONS OF ALGOL VARIABLES —An important paper by Col F E Markwick (B A A Journal vol 35 No 2) contains discussions and light curves of six Algol variables from observations by himself and other members of the Variable Star Section They are a good example of the useful results that can be obtained in this field by careful and long continued visual estimations of magnitude The curves for three of the stars show secondary minima U Ophiuchi loss of light at secondary minimum 0 2 mag RW Tauri 0 2 mag / Vulpeculæ 0 1 mag They did not succeed in detecting the secondary minimum of Algol but the curve of principal minimum is shown in great detail The total number of observations used is 2630 they begin in 1906 for most of the stars 1899 for Y Cygni The period found for Algol is 2 867265 days which is 3 9 sec shorter than that given by Chandler The range of the observations used is 5336 days or 14 6 years The commencement and end of the principal eclipse are more rounded than those on Stebbins s curve The effect is to make the total duration of eclipse 14·09 hours which is longer than is generally given but Col Markwick defends his curve on theoretical grounds

Research Items

HUMAN REMAINS FROM ANCIENT GOLD MINES IN RHODESIA.—In view of the conflicting interpretations of archæological evidence in Rhodesia any human remains to which any degree of antiquity can be attributed are likely to be of importance for the early racial history of that area. Considerable interest therefore attaches to a report by Sir Arthur Keith on two skeletons from ancient gold mines which appears in Vol. xxii. of the Proceedings of the Rhodesian Scientific Association. The Que que skeleton was found 4½ ft. below the surface in a filled in working. It is represented by numerous fragments all weathered, partly dissolved and fallen into pieces. They are only lightly mineralised, yet have the appearance of having been buried for a considerable time, possibly a thousand years or more. Such characters as can be recognised indicate a young female of about 18 years of age, of an estimated height of 5 ft. 1 in., and belonging to the negro race. The second specimen, from Belingwe, is a pure negro type, male, between 20 and 30 years of age. The skull is small, length 182 mm., breadth 124 mm., index 68, cranial capacity 1220 cc. A remarkable feature is the projection of the alveolar bone 9 mm. beyond the nasal spine and its wide simian nasal grooves. The skull is mineralised to a certain extent and somewhat more ancient than the Gwanda woman (described in the Proceedings of the Rhodesian Scientific Association, Vol. xxi.), whose stature has now been calculated as 4 ft. 9 in. These measurements are comparable with those of two skeletons of ancient man from Rhodesia described by Dr. F. C. Shrubsall in *Man* in 1909. Thus all the remains we have from ancient ruins or mines in Rhodesia are of the Negro or Bantu type, and show no trace of Arab, Egyptian, Bushman or Hottentot strain.

PALÆOLITHIC INDUSTRY IN NORTHERN CHINA.—T. de Chadin and F. Licent (Bull. Geol. Soc. China, iii., 1924, p. 45) record the discovery of palæolithic floors at three different places in Inner Mongolia. The floors are found at the base of the Loess and in the Loess itself, and the associated mammals include rhinoceros, hyena, gazelle, antelope, horse, bison, elephas, etc. The implements are made of quartzite, psammite and silicified limestone, and appear to be of Mousterian or early Aurignacian type. In the same regions in which palæolithic implements are found in the Loess, evidence of neolithic man is shown by the presence on the surface of the earth of polished axes, arrow heads, knives and borers.

VITALITY OF JELLY FISH.—It is a remarkable fact that many of the lower animals are able to live for a long time without food, maintaining themselves during the period of starvation at the expense of their own tissues and not merely by means of reserve stores of fat or other substances. A very interesting case of this kind is described by Messrs. de Beer and Huxley in the *Quarterly Journal of Microscopical Science* (vol. 68, part 3). They found that the common jelly fish *Aurelia aurita* can be kept alive without food in laboratory aquaria for as much as thirty-eight days, during which time they undergo a progressive decrease in size, accompanied by loss of morphological and histological differentiation. The bell begins to shrink first, the oral arms later. Tentacles and thread cells disappear, and the gastro-vascular cavity closes up, the final result being a very small shapeless mass. The bell continues its pulsations until an advanced stage of the process has been reached. It will come as a surprise to many naturalists that such a delicate organism as Aurelia can remain alive for so long under such unfavourable conditions.

THE BORING MECHANISM OF TEREDO.—The manner in which the ship-worm bores into timber has been a matter of conjecture and dispute among naturalists for at least two centuries. Some have supposed the soft fleshy foot to be capable of rubbing away the fibres of the wood, perhaps with the help of a solvent or softening secretion; others have regarded the valves of the shell, with their file-like rows of teeth, as the instruments of boring. It has been reserved for Mr. R. C. Miller (Univ. California Publ. Zool. xxvi., No. 4, pp. 41, 8o, 4 pls.) to give what appears to be a conclusive answer to the question. After a detailed account of the structure of the shell, the foot and the muscles connected with them, he discusses the possible methods of boring that have been suggested. He points out that the foot is covered with columnar epithelium becoming glandular and ciliated near the edges and obviously unfitted for abrasive action. The possibility that some solvent enzyme may be secreted is not altogether excluded, although an analysis of shavings from the inside of the burrow showed no significant difference in composition from sound portions of the same block. The presence of tool-marks—scratches corresponding with the serrations of the shell—on the inside of the burrow, which has often been denied, is admirably demonstrated by a series of photographs. Finally, by laying bare the inner end of the burrow and sealing a cover glass over the opening, the author succeeded in watching the Teredo at work. It was found that the movements of the animal in the burrow were effected chiefly by means of the suctorial and surprisingly mobile foot. Boring was seen to be accomplished by rhythmical movements of the valves of the shell, which were held in position by the combined action of the foot attached to one wall of the burrow and the dorsal fold of the mantle pushing against the opposite wall.

THE CHANGING COLOUR OF THE MINNOW.—The minnow (*Leuciscus phoxinus* sive *Phoxinus lævis*) is one of those species of fish in which the male in the breeding season assumes brighter colours. Mr. Leo Abolin's communications (Beeinflussung des Fischfarbwechsels durch Chemikalien. Pt. I. Infundin- und Adrenalinwirkung der Melano- und Xanthophoren der Elritze. Pt. II. Annahme männlicher Erythrophoren-färbung durch das infundibulisierte Weibchen der Elritze. Nos. 119 and 120 *Mitteilungen aus der Biologischen Versuchsanstalt in Wien, Zool. Abt.* under the direction of H. Przibram) give a most interesting explanation of the mechanism by which this is brought about. From the first paper we learn that the colour of the fish is mainly due to black and yellow pigments contained in cells termed melanophores and xanthophores respectively. These cells are situated in two layers of the skin, a deeper and a more superficial. Injections of minute doses of weak solutions of adrenalin contract the melanophores and cause the fish to assume a pale yellow colour, the effect passes off in about two hours. Injections of similar doses of post-pituitary extract cause expansion of the melanophores of the under layer and of all the xanthophores. The grey colour of the fish becomes greenish and the belly, which is normally silver, becomes golden yellow. If the fish is blinded the injection causes intense expansion of the melanophores in the sensitive regions of the body (the lips, gill-covers and the sub-branchial region of the head), but the xanthophores do not expand. The same

result is obtained if the sympathetic system is destroyed only in this case both layers of melanophores are expanded and the xanthophores are contracted in fish which lie on a dark surface the same result follows under normal conditions From the second paper it appears that in the superficial layer of the skin on the lips the bases of the fins and on the belly there is contained a certain amount of red pigment embedded in cells termed erythrophores When the male becomes ripe these erythrophores become widely expanded as do the melanophores and xanthophores This same result can be obtained in ripe females and in small unripe males and females in which no trace of red is externally visible by the injection of somewhat strong doses of post pituitary extract (one tenth per cent) It is therefore obvious that the bodies of males and females so far as pigment is concerned have the same structure and that the secondary sexual characters of the male are due to the action of the distinctively male hormone on this common groundwork

YEASTS FATS AND ALCOHOL FROM SEAWEED — We have recently received from Prof Nadson of the Principal Botanical Garden Leningrad a short type written communication from which it appears that the possibility of the commercial utilisation of sea weeds is at the present moment occupying the attention of Russian chemists The paper in question is entitled Seaweeds as a Source of obtaining Yeast Fat and Alcohol and contains a brief summary of the results obtained by Prof Nadson working in collaboration with Messrs A G Konokotina and G K Burgvitz The authors claim to have succeeded in growing both bakers and brewers yeasts (of the type of *Saccharomyces cerevisiæ* I Saatz Frohberg etc) upon autoclave extracts of *Laminaria saccharina* and from the results obtained they conclude that it should be profitable to produce compressed bakers yeast and dry Nährhefe of high protein content in this way They have moreover apparently succeeded in producing an abundant growth of fat yeast *Endomyces vernalis* Ludw upon minced and boiled *Laminaria saccharina* cultures kept at 6 8° C for sixteen days are stated to have produced a yield of 6 22 per cent of fat upon the medium as compared with a normal content of only 0 3 to 1 per cent of fat in the untreated weed On the strength of these results the authors recommend the use of seaweed as a substrate for the production of fat for technical purposes The authors further state that they have produced alcohol from a decoction of *Laminaria saccharina* prepared by soaking 5 per cent of finely ground material in water for 12 14 hours and sterilising at 110° on this they have grown three different kinds of yeast (1) Strains of *Saccharomyces ellipsoideus* Saatz and Frohberg (2) yeasts isolated from fermenting sugar beets—*Saccharomyces betæ* and (3) torula isolated from the surface of the living *Laminaria saccharina* of Murman No data are given as to the yields of alcohol obtained but it is claimed that the distillation of alcohol from algæ gives several valuable by products The information supplied in this communication is scarcely sufficient to carry very much conviction The object of the publication may be best stated by quoting the authors own words We are giving the results obtained by us in order once more to direct attention to the sea weeds of Russia as one of her natural riches awaiting their utilisation

CRETACEOUS FAUNA AND FLORA OF SHANTUNG — An extensive series of freshwater deposits formed in a continental basin in Shantung is described by H C Tan (Bull Geol. Survey of China No 5 pt. 2 1923) and is believed to be mainly of Cretaceous age Numerous fossils have been found in the deposits and furnish interesting evidence of the plants and animals which during a long period of time lived on land or in fresh water They include dinosaurs, fishes freshwater molluscs such as Unio Leptesthes Cyrena Bithinia and Valvata insects belonging to the orders Orthoptera Blattoidea Coleoptera Odonata Lepidoptera Diptera etc The plants are mainly conifers and cycads Descriptions and figures of some of the molluscs and insects are given by A W Crabau

SOMERSET OIL SHALLS —Messrs H G Shatwell A W Nash and J I Graham recently communicated an account of the Somersetshire oil shales to the Institution of Petroleum Technologists These shales outcrop for about ten miles along the coast in the vicinity of Blue Anchor and extend inland for a distance of one to three miles They form part of an argillaceous and calcareous group of sediments which have been assigned to Lower Lias and Rhætic horizons and their mode of occurrence is in two basins lying on either side of the Devonian Quantock Hills the larger basin (Lilstock Basin) being situated on the east the smaller (Doniford Basin) on the west Bituminous shales of Lower Lias age have long been known from the opposite South Wales coast and the authors conclude that the Somerset shales are a continuation of these The Somerset shales occur in beds varying from 1 to 20 feet in thickness those of South Wales being much thinner 6 inches to 5 feet Proximate analyses of the Somerset shales show that they have an average specific gravity of 2 4 from 70 to 73 per cent of ash 3 5 per cent of moisture 23 to 28 per cent of volatile matter (less water) 1 70 to 4 52 per cent of sulphur and 13 to 17 per cent of carbon dioxide The specific gravity is higher than the Scottish oil shale which averages 2 0 while the high carbonate content is unusual Results of assays and steam distillations carried out by the authors show that the yield of oil from one ton of shale is about half that of the average yield from the same quantity of Scottish shale the total amount obtained from the Somerset shales varied from 5 00 gallons to 10 4 gallons ammonium sulphate from 4 to 6 lb and gas from 1200 to 1900 cubic feet per ton The crude shale oil has an average specific gravity of 0 939 and sulphur content up to 3 12 per cent it is dark brown in colour and has a less sweet odour than that distilled from Scottish shale On fractionation naphtha (specific gravity 0 807 to 0 852) kerosene (0 888 to 0 925) and heavy distillate (0 973) are obtained distillate above 300 C failed to yield more than a trace of paraffin wax From the above details it will be gathered that the Somerset oil shales notwithstanding the comparatively low sulphur content of the oil obtained from them do not inspire confidence from a commercial point of view

RAINFALL IN MYSORE —The Meteorological Department of the Mysore Government has issued a Report on Rainfall Registration for 1923 prepared under the supervision of Mr C Seshachar the Meteorological Reporter There were 226 stations gauging rainfall during the year The greatest rainfall on any one day was 17 90 inches at Agumbi in the Shamoga District on August 7 the heaviest record in 1922 was 22 16 inches at the same station In the Kadur District the heaviest fall in 24 hours was 16 85 inches at Bijrapur Estate on July 24 and in the Hassan District at Marnhalli toll gate the fall in 24 hours on August 14 was 11 43 inches In no other District did the fall in 24 hours amount to 5 inches July was the wettest month on record since 1893 the year in which the

Meteorological Department was organised; the monsoon was unusually active in the western parts of the State. A monthly total of 202 inches was recorded at Byrapur Coffee Estate against a normal of 106 inches. The south-west monsoon period, June to September, was generally wet, the total rain over the State being 26 per cent above the normal. The north-east monsoon period, October to December, was the driest on record since 1893. The deficiency varied from 66 per cent in the Mysore District to 89 per cent. in the Chitaldrug District. The seasonal aggregate for the State was 1·95 inches against a normal of 8·04 inches, which is 76 per cent. in defect of the normal. The largest annual total for a single station was 393·64 inches at Agumbi in the Shamoga District, and the smallest was 4·36 inches at Dharmapur in the Chitaldrug District. Rainfall maps are given, which help much to a complete understanding of the work.

A Shunted Grassot Fluxmeter.—A Grassot fluxmeter may be described as an over-damped moving-coil ballistic galvanometer having practically no controlling force. This instrument is of great value for measuring magnetic flux. Gisbert Kapp, in his book on "The Principles of Electrical Engineering," suggests the possibility of increasing the range of the instrument by using a shunt, but he gives neither the theory of how it would work nor the formulæ that would have to be used with it. In April 1924 Masamiti Sase read a paper to the Physico-Mathematical Society of Japan in which he gives the complete theory of the multiplier, and gives experimental results confirming it. In the instrument he used, the highest permissible value of the shunt was about 8 ohms, which was about one-third of the resistance of the fluxmeter. He shows that it is desirable to use a shunt of manganin wire having the highest allowable resistance. His results prove conclusively that the particular Grassot fluxmeter with which he experimented could be used with a shunt of 8 ohms even when the highest accuracy is required. This greatly increases the range of the instrument.

The Evidence of the Proof Plane.—Mr. J. Clark, writing from Kewanna, Manitoba, directs attention to a method of dealing with observations made with the proof plane. When such a plane, without electrical charge, is introduced into the electrostatic field surrounding one or more conductors, one at least of which is charged, it will have, at each point in space, a definite potential V_p, depending on the external charges and the equal charges of opposite signs induced upon it. This potential Mr. Clark calls the potential of the free charge of the proof plane. If, then, the plane is brought up to a large insulated conductor, the total charge of which is zero, without actually making contact with it, the potential V_p will, in general, differ from the uniform potential V_c of the conductor, being greater than V_c on one side of the conductor and less on the other. If now the plane is made to touch the conductor, electricity will flow from the plane to the conductor in the first position, and from the conductor to the plane in the second, so that when the plane is removed from the field, and brought to an electroscope, it will be found to have a negative charge in the first case and a positive charge in the second. It is not always possible to regard the proof plane as temporarily forming a part of the surface which is being tested, since this is often curved, and the method suggested will often prove valuable.

A New Diamagnetic Phenomenon in Gases.—An investigation of the diamagnetism of hydrogen, nitrogen and carbon dioxide, at different pressures, is described by Dr. A. Glaser in the *Annalen der Physik* for October. A rod of diamagnetic lead glass was suspended inside the experimental tube containing the gas, by a 2-5μ quartz thread attached to a torsion head. Thin threads of paramagnetic cobalt glass were melted on to the rod, so that the whole became slightly paramagnetic. The tube was surrounded by a water jacket by means of which the temperature was kept constant to within 0·01° C. In each observation the torsion head was twisted to bring the light spot to zero. As the pressure was diminished the susceptibility at first diminished in proportion; but in each of the gases this ceased to be the case at a pressure which depended on the nature of the gas and the intensity of the field. Thereafter the rate of diminution of susceptibility with pressure diminished greatly for some time, and in the end, at low pressures, the susceptibility was three times as great as it would have been if the original rate of diminution had been maintained throughout. It is suggested that, at low pressures, the distance between the molecules is such that there is time between collisions for them to become oriented with respect to the field. At higher pressures the collisions are constantly destroying any tendency to orientation which may be produced, so that all the molecules are practically unoriented.

A New Lead Accumulator.—In the *C.R. Acad. Sci. Paris*, November 24, M. C. Féry describes a lead accumulator which does not sulphate, even if discharged and left uncharged for two years, at the end of which time it can be recharged in the ordinary manner. The author has previously shown that the true reaction taking place in the Planté cell is given by the reversible equation,

$$Pb_2 + H_2SO_4 + Pb_2O_5 = Pb_2SO_4 + 2PbO_2 + H_2O,$$

and that $PbSO_4$ is only formed accidentally when the cell becomes "sulphated." Pb_2O_5 is a black peroxide, and Pb_2SO_4 is greyish black in colour. The spontaneous discharge of the Planté cell is due to the combined action of the electrolyte and of oxygen on the negative plate, according to the equation

$$Pb_2 + H_2SO_4 + O = Pb_2SO_4 + H_2O,$$

and this action may develop into

$$Pb_2SO_4 + H_2SO_4 + O = 2PbSO_4 + H_2O$$

if the cell is left undischarged too long. To avoid this, the author places the negative plate at the bottom of a deep glass jar, and separates it from the positive, and from the air, by a porous material containing the electrolyte. A figure in the original paper shows the cell as it appears when partly discharged, with a layer of black plumbous sulphate on the upper surface of the negative plate. A cell left without recharge for twenty-six months only lost 66 per cent. of its original charge, the loss in the first month being 4 per cent., 83 per cent. of the original charge remaining after four months, while an ordinary cell would have lost the whole of its charge in this time.

Erratum.—In Nature of December 20, p. 909, in a paragraph on the "Cytology of Cotton," referring to the work of Mr. H. J. Denham, it is suggested that the reason for the appearance of Mr. Denham's papers in the Journal of the Textile Institute as well as in the *Annals of Botany* is the importance of the work to the cotton-growing industry of the British Empire. We learn that the work referred to was carried out at the laboratories of the British Cotton Industry Research Association, and permission to publish it in the *Annals of Botany* was given on the understanding that, in common with all papers from the Association's laboratories, it would be published in the Journal of the Textile Institute.

The Japanese Earthquake of 1923

MR K SUDA of the Imperial Marine Observatory at Kobe has recently issued a detailed and interesting report on the great Japanese earthquake [1] It is based on an examination of all the seismograms obtained at Japanese observatories and on an exploration of the central tract from September 19 to October 12 The following is an abstract not of the whole memoir but of those portions which have not been fully treated in earlier papers [2]

It is not often that isochronal lines (the coseismal lines of Mallet) can be drawn for any earthquake The large number of earthquake observatories in Japan and the radio time service have enabled Mr Suda to give a series of such lines certainly the most accurate of any yet attempted They are drawn for every ten seconds except towards the north east From the epicentre to a distance of 200 km the curves are extremely irregular Beyond this distance they become portions of nearly concentric circles and the distance between successive curves increases with the distance from the origin The curves in the north east of Japan are packed more closely together than in the south west The irregularity of the curves is due partly to geological conditions partly to the form of the focus

On the same map are shown the initial directions of the shock These are not always directed towards or from the epicentre small deviations being experienced at several places due chiefly perhaps to the geological structure of the country The initial motions are condensational (or from the origin) at nearly all the observatories to the south west of the line from Matsumoto to Kofu Between this line and that from Niigata to Fukushima (that is in the region including the central zone) condensational and rarefactional movements are mixed together To the north east of the latter line the initial motions are again with few exceptions condensational The complexity in the intermediate region may be connected with the nature of the displacement that caused the earthquake The directions of initial motion are usually normal to the isochronic lines Smoothing off the local variations in these lines the space time curve is drawn It cuts the time axis at a point corresponding to 11 h 58 m 26 s the time of occurrence at the epicentre considered as a point The velocity of the primary waves near the epicentre was 5 5 km per sec that of the large waves was constant and about 3 59 km per sec

One more result obtained from the study of the seismograms may be referred to The angle of emergence at Kumagaya was 21° and at Choshi 13 5° At Mera the epicentral distance is 46 km and the focal distance (as determined by the duration of the preliminary tremor) 70 km ; at Tokyo these distances are 82 km and 98 km The focal depths given by these four observations are about 50 35 54 and 55 km the average being 48 km

Mr Suda adds some interesting details about the changes of level along the coast of Sagami Bay Since the earthquake, the land has shown a tendency to return to its original level For example, at Misaki (near the end of the Miura peninsula) the elevation on September 1 was about 760 cm and the sea bed between it and a small island in front was laid bare On September 5 the land here began to sink at first at the rate of nearly 60 cm a day then more slowly until on September 26 the uplift was only about 140 cm Similarly at Tateyama at the end of the Bo-so peninsula the uplift on September 1 was 220 cm Later in the same month it was reduced to 140 cm The first upheaval and the subsequent sinking were both most marked at the ends of these peninsulas There is also evidence that at both points the land had been slowly sinking for many years before the earthquake At Shitsura near the end of the Miura peninsula the land had sunk about 2 metres during the preceding sixty years and some of the farms near the shore had become covered by the sea After the earthquake the land was restored to its former level The remarkable changes of level in the floor of Sagami Bay have been referred to in NATURE (vol 113 pp 473 474) The first soundings were made soon after the earthquake They have since been repeated with great care and a comparison of the two maps reveals no great differences The *tsunami* or seismic sea waves were comparatively low The greatest height attained was 11 metres at Atami where 155 houses were washed away and about 60 persons were killed Mr Suda attributes the small height of the waves in part to the upheaval of the land round Sagami Bay

One of the most interesting chapters in the memoir is that on after shocks Omori had found empirically that the decline in frequency of after shocks follows a hyperbolic law The theoretical investigation by Prof S Kusakabe shows that the decline takes place according to a logarithmic law of which Omori's law is a particular case and that the frequency-curve approaches or deviates from the hyperbolic form according as the time during which the stresses causing the earthquake act is long or short As the curves for different observatories are nearly hyperbolic it follows that the great earthquake was tectonic and not volcanic in origin Mr Suda however points out a remarkable feature in all the frequency curves whatever the distance from the epicentre From the first to the third days the curve is hyperbolic and after the fourth day again hyperbolic but with a lessened value of the constant For example at Kumagaya the frequency curve is at first represented by the equation $xy = 327$ but after the fourth day by the equation $xy = 242$ Mr Suda infers that the stresses that caused the earthquake began to operate again after three or four days and that in consequence the frequency of after shocks was distinctly less after this time He suggests that these districts will probably be visited periodically by great earthquakes until the stresses causing them are changed

The after shocks are divided by Mr Suda into two classes which he calls the Sagami Sakawa family and the Bo so family the former occurring in an area to the west of a north south line passing just to the east of Oshima and the latter in an area on the east side After shocks of the Bo so family were usually stronger than the others and had a longer vibration-period The greatest of the Bo so series was that on September 2 at 11 h 47 m which was nearly as strong as the great earthquake The epicentre lay off Katsuura on the Pacific side of the Bo so peninsula and the first displacement within the focal region occurred in a vertical plane for the initial motion at every observatory near the epicentre was directed outwards Mr Suda points out an interesting relation between the frequency of the after shocks generally and the atmospheric pressure the rate of pressure change and the pressure gradient The frequency is slight or great according as these conditions are the same as or contrary to those which prevailed on the day of the earthquake

The theoretical portions of Mr Suda's memoir interesting as they are must be passed over more

[1] Mem. Imp Marine Obs. Kobe Japan vol 1 1924 pp 137-239 tables 1-49, and 38 plates.
[2] NATURE, vol. 113, pp. 234, 473-474 vol. 114, pp 70 202, 484

rapidly. He considers that there were two epicentral zones, one directed north-north-east in the central part of Sagami Bay, the other intersecting it and directed north-west. The former coincides with the great region of subsidence in the bay, and this subsidence produced the condensational initial motion around the epicentre. Beneath the second epicentral zone, he thinks, there was a horizontal sliding of a layer of the crust towards the south-west, which would produce condensational motion on the south-west side and rarefactional motion on the north-east side. The vertical displacement beneath the first zone being the more important, the condensational initial motion prevailed at some distance from the origin. Among the secondary causes of the earthquake Mr. Suda includes the typhoon which was passing over the northern part of the epicentral region at the instant when the earthquake occurred. C. D.

Italian Theses on Chemistry and Physiology.

THE twenty-sixth volume of reports, recently issued by the Cagnola Scientific Foundation, covers the period 1917–1923 and deals with the essays on various scientific subjects submitted for adjudication to committees appointed by the Royal Lombardy Institute of Science and Literature. The subjects vary widely in character, but are all of medical or chemical interest. In a few instances only have the theses presented been deemed worthy of reward, and of the successful theses, four only are printed *in extenso* in the present volume.

In "The Chemio-therapy of the Spirilli," which extends to over 160 pages and is accompanied by many plates, diagrams, etc., Prof. Giorgio Castelli gives, in addition to a succinct account of previous knowledge of this subject, the results of his own numerous experiments, which lead to various important conclusions. The slight increase in the efficacy of the curative agents determined by prolonged contact of the latter with the air during the manipulation is insufficient to compensate for the dangerous increase often observed in the toxicity. Oral administration of the arsenobenzenes is not to be recommended, and the use of dimethylaminotetraminoarsenobenzene, proposed by Giemsa, is not only less effective than that of salvarsan or neosalvarsan, but is also followed by more frequent and more ready relapse. Increased toxicity is also against the employment of compounds obtained by the introduction of amino and other nitrogenous groupings, sulphur, etc., into the molecule of arsenobenzene. In some cases augmented therapeutic efficacy is attained with compounds of salvarsan with silver or copper salts, but here too the frequency of undesirable after-effects militates against the application of such compounds on a large scale.

Prof. Aldo Perroncito, in a short contribution on the derivation of blood platelets, demonstrates the possibility of the formation of new platelets independently of the elements of all other tissues of the organism. In blood drawn from the jugular vein of the cat or dog, and treated with sodium citrate to render it non-coagulable, and then with pyrodin solution, the number of the platelets becomes doubled or, in some instances, even quintupled after the blood has been kept at 38° C. for about an hour. Exclusion of the intervention of either the corpuscles or the plasma leads to the conclusion that the platelets are capable of reproducing other elements with similar morphological characters.

In his memoir entitled "Catalytic and Enzymic Phenomena," occupying 130 pages and including a very useful bibliography, Prof. Ugo Pratolongo develops a novel interpretation of recent results arising from modern mechanico-static theories of chemical phenomena. He has succeeded in distinguishing in chemical kinetic equations the terms depending on piezometric actions and on medial actions from terms proper to the mechanism of the reaction. The application of this principle to well-known accelerating reactions shows that some of these are definitely catalytic in nature, inasmuch as a change in the mechanism of the chemical reaction, and hence in the critical energy relative to the reaction, is involved; others are of medial character, and others again—heterogeneous catalyses—possibly depend on variations in the active concentration of the reagents induced by the catalyst. The experimental results show that, in the decomposition of hydrogen peroxide, the critical energy assumes values depending strictly on the metal functioning as catalyst and independent both of its method of preparation or state of subdivision and also of the presence of activating or inactivating agents. Thermal inactivation of a catalyst consists of partial destruction of the catalyst, the remaining fraction retaining its activity unaltered.

Under the title "Interchange of Hæmoglobin in Physiological and Pathological Conditions," Dr. Enrico Greppi discusses the different factors operative in the continual destruction (hæmolysis) and reformation (hæmoglobinogenesis) of the blood-pigment.

Astronomical Observations at Greenwich and the Cape.

THE first impression on seeing the annual volume for 1921 of "Greenwich Observations"[1] is its thinness in comparison with the volumes of two or three decades ago. It appears to be the least bulky in the last hundred years. This is due to a reduction accomplished during Sir Frank Dyson's tenure of office by the suppression of much of the detail of the observations, but enough is still given to show the data on which the tabulated observations depend.

The results are given concisely and orderly, and they represent an immense amount of routine work which is carried on from year to year at Greenwich, a work never in the limelight but, on its astronomical side at least, the basis for the discussion of all the problems of fundamental astronomy.

The observations with the Transit Circle take up the first section, and show the state of adjustment of the instrument from day to day, and then give the observations of right ascension and declination of the sun, moon, and planets, together with the observed errors of the tabular place as given in the Nautical Almanac. More than 17,000 observations were made in connexion with the Transit Circle in the course of the year. The observations of the moon have been combined with the extra-meridian ones taken with the Altazimuth, and give the error both of the Nautical Almanac (Hansen's tables with Newcomb's corrections), and Delaunay (Connaissance des temps,

[1] Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1921.

Radau's tables). It is of interest to note that the latter corrections are much the smaller

The observed errors of the wireless time signals received from Paris, Nauen, and Annapolis are shown in Table IV. (p. A 16). The range of error, from about 0·2 sec. early to 0·4 sec. late for each of the three observatories, is rather large when the installations for determining and keeping time at the observatories concerned are considered The observations, however, have not been corrected for errors in the sending It is not stated to which series of morning signals the Paris observations refer, and it would be of value to any one discussing these results to know whether the beginning, middle, or end of the signal was referred to the local clock beat

The next section deals with the measures of the photographs of the sun taken at Greenwich, the Cape, Kodaikanal, and Dehra Dun Thanks to this co-operation, photographs were available for each day of the year. There is a pronounced decline in the mean daily area of spots, corrected for foreshortening, from 1052 (1919), 618 (1920), to 420 (1921) Similar figures for the faculæ are 1729 (1919), 1219 (1920), to 739 (1921), the unit being the millionth of the sun's visible hemisphere The last section gives the usual details concerning the magnetical and meteorological observations These form about one-third of the whole volume. Plates show the magnetic disturbances for three consecutive days, May 13, 14, and 15

In one respect the title, "Greenwich Observations, 1921," does the book less than justice Except in the annual report at the end of the volume, there is, for example, no mention of the work done with the Thompson Equatorial, with which more than 1000 parallax plates were taken, and almost as many measured There is no question that the national observatory at Greenwich continues to maintain its high standard of duty and performance, though one may require to read between the lines to prove it

The Cape portion of the Astrographic Chart and Catalogue extends from declination $-40°$ to $-52°$ The volume of the catalogue now issued [1] is the eighth of this series to appear The previous members, numbers I.-VII., give the measures in the seven zones from $-41°$ to $-47°$, the first appearing in 1913, and the last in 1923.

The present volume was delayed in printing, apparently by the War, for the introduction was signed by the late Mr S S. Hough in 1916 It contains the measures of the rectangular co-ordinates of all the stars shown on the plates having their centre on the declination circle $-50°$

The introduction gives a short description of the telescope, the method of measurement of the plates, the process followed to guard against errors in the measuring, and the further checking of the results by the intercomparison of overlapping plates It is evident that great care has been taken to eliminate errors

The plates were exposed during the years 1902–1908 and measured with two exceptions between November 1907 and September 1908 The catalogue gives the measures of the x and y co-ordinates to 0·001, an estimation of the diameter of the image, together with the identification by number and magnitude of the star in the Cape Photographic Durchmusterung, if it occurs in that catalogue No attempt is here made to convert these estimates of stellar diameter into a standard scale of magnitude.

The catalogue proper consists of 465 pages, with a total of 79,105 stars, or a distribution for the first 12 hours of R.A of 32,504 and for the last 12 hours of 46,601

[1] Catalogue of Rectangular Co-ordinates and Diameters of Star Images derived from Photographs taken at the Royal Observatory, Cape of Good Hope Zone $-50°$

Annual Meeting of the Geographical Association.

THE annual meeting of the Geographical Association was held at the London School of Economics on the first three days of January The gathering was remarkable for an extraordinarily valuable series of papers of high scientific worth, for a broadcast message by Prof J. L. Myers, the president, and for a continuation of the plan of inviting a distinguished continental thinker, in this case Dr A Sommerfelt, of Oslo, to speak

In his presidential address, Prof Myers dealt with the historical method in ethnology and with cogent argument and gentle banter criticised the conclusions of some investigators, especially Mr Perry, who, applying the hypothesis of long distance diffusion of culture, announced as discoveries speculations which recalled extreme conclusions of Max Müller on the Aryan Race or those of the Anglo-Israelites on the lost tribes

Among the other papers two stood out as remarkable One was entitled on the programme "Life among the Hill Tribes of Algeria." It cannot be described satisfactorily either as a description illustrated by films or as films with appropriate comments, for the first of the noteworthy points just was that it was a coherent whole in the sense that the words and music of a good song are coherent The kinema was in fact seen at its best as an educational instrument of the highest class. It is not easy to make it so, but that it can be done is evident. The second point is that what was done was worth doing. The films were thoroughly scientific, extremely human, entirely free from anything meretricious and yet extraordinarily interesting. They are the property of Mr J A Haeseler, who is collecting a scientific library of such films, and they had been taken with the help of Capt Hilton-Simpson, who gave the address They showed the actual life of the people basket-making, shoemaking (with platted grass), making of wooden door-locks with an adze strikingly like a bronze age tool, quern-making and corn grinding, ploughing, skinning a goat and the processes by which the skin is turned into a water-bottle, and bread-making, but perhaps the most fascinating of the pictures were those showing the fundamental arts of textile and pottery making Spinning was exhibited as carried on by two or three of the simplest possible methods, one even without the aid of a spindle, while two types of simple looms, and the entire operation of weaving from the making of the warp and setting up of the loom to the final process of inserting the woof, was shown with wonderful clearness So also clay was obtained from a pit, freed from stones, and a pot gradually built up before one's eyes without—and this is the remarkable fact—the aid of the potter's wheel The ornamenting of the pot, the firing, the fire being lit by a boy, and the glazing of the still hot vessels were equally clearly shown

The performance—it is difficult to find a satisfactory word for the combined appeal to eye and ear—gave an insight not only into the geography of another land, but also into conditions of a long past time very thinly veiled by later growths and accretions We have said that the kinema was seen at its best This was because it was used for what it is best fitted. It was used to show things as they happened,

dynamically, not statically. We might perhaps qualify our statement and say "almost at its best" It would have been better, though impracticable, to show several of the films again. Even when one knew what to look for, it was quite impossible to follow all the details of what was done. Further, it was obvious that while for exhibiting processes the film is the superior, yet for still life and for analysis the slide has still the advantage

The other paper was by Mr C E P Brooks and was entitled "The Climatic History of the Fiord Countries" Climatology is still in its infancy, and this is one of the few papers which deal with climatic, as distinct from meteorological, problems without becoming unintelligible amid a maze of statistics Mr Brooks traced out the succession of climates during and since the Ice Age, if indeed we are out of the Ice Age He suggested that the Daun stadium should be dated round about 1800 B C rather than 5000 B C , and estimated the temperature of the Norwegian coast at 5000 B C to have been 4° higher than at present His most striking suggestion related to the causes of these climatic changes He associated them with variations in the ice conditions in the Arctic Ocean Analysis of these conditions by Kerner Marilaun and himself has shown that the Arctic floating ice-cap must either have its present extent or the whole ocean must be free of ice, no intermediate stage being stable. He related the voyages of the Norsemen, who in their voyages to the south of Greenland mention storms but never ice, and the great Asiatic migrations, to an open period in which the Arctic was unglaciated, and concluded, "In the twelfth century the glacial stage recurred and has apparently persisted to the present day" So we are still in the Ice Age!

Periodicals in Canadian Libraries.[1]

THE need for co-operative library catalogues of scientific periodicals has long been felt in many countries, and various projects have been undertaken to supply the deficiency The work before us is an attempt to provide for those specially interested in scientific periodicals, and consists of a list of such material available in Canadian libraries, together with bibliographical information Journals are arranged under their latest form of title, and publications of academies under the name of the society or institution In our opinion, this method of listing the publications of academies does not facilitate their ready identification Under the words "Kaiserlich" and "Koniglich" there are quite a number of entries, although events of recent years have caused these adjectives to be dropped or replaced As an example, the Koniglich-Preussische Akademie der Wissenschaften is now known as the Preussische Akademie, though this fact cannot be ascertained from the present work. Had publications of this character been listed under the first word of their title—in this case Sitzungsberichte—consultation would have been simplified.

It is to be regretted that a number of Canadian libraries, whilst those responsible realised the importance of the work, were unable to include their possessions in this list The reasons given were that periodicals were not catalogued or that the staff at their disposal was inadequate. It is obvious that full advantage cannot be taken of the resources of Canadian libraries if a proportion of them are compelled to neglect the preservation and cataloguing of serials. Further, Canadian science will be under a distinct handicap until steps are taken to provide the libraries with adequate competent assistance.

Despite the difficulties confronting them, the compilers have produced a work which should prove of considerable aid to scientific workers in the Dominion, and they are to be congratulated upon the completion of a volume which bears evidence of much care and painstaking labour. Due credit should also be given to the Canadian Department of Scientific and Industrial Research, the material co-operation of which enabled the early publication of the volume.

F. W. CLIFFORD.

[1] A Catalogue of Scientific Periodicals in Canadian Libraries Prepared by Dr Gerhard R Lomer and Margaret S Mackay Pp. xx+255 (Montreal: McGill University, 1924.) n p

University and Educational Intelligence.

ABERDEEN —The Fullerton Research Scholarship in natural science has been awarded to Miss Elizabeth T Geddes.

GLASGOW —The King has been pleased to approve the appointment of Mr. James Montagu Frank Drummond to the regius chair of botany in the University, vacant by the retirement of Prof F. O. Bower. Mr Drummond took first-class honours in the Natural Sciences Tripos at Cambridge in 1904, and gained the Frank Smart Studentship for research in botany at Gonville and Caius College He became lecturer in botany at Armstrong College, Newcastle-upon-Tyne, and in 1909–1921 was lecturer in plant physiology in the botany department of the University of Glasgow Since 1921 he has been Director of the Scottish Plant Research at Corstorphine, Edinburgh During the War he served in Palestine, Egypt, and France, acting as battalion intelligence officer, and afterwards as brigade education officer His published works refer chiefly to plant physiology, but include a series of papers on the "Botany of the Palestine Campaign" communicated to the Linnean Society

LONDON —The lectures which were to have been given early this month by the late Prof J. I. Hunter at University College on "The Anatomy and Physiology of the Sympathetic Innervation of the Striated Muscle" will be delivered by Prof. G. Elliot Smith on January 19, 26, and February 2 at 5 o'clock.

The degree of Ph.D in Science has been conferred on Mr. W. Jevons (Imperial College—Royal College of Science) for a thesis entitled "Spectroscopic Investigations in connexion with the Active Modification of Nitrogen" and other papers.

NOTICE is given by the Imperial College of Science and Technology, South Kensington, of the alteration in the date of the Entrance Scholarship Examination, which in 1925 will begin on April 24. Eighteen Scholarships, value 62*l* 10*s* each, are offered, six being tenable at the Royal College of Science, six at the Royal School of Mines, and six at the City and Guilds (Engineering) College, for admission at the beginning of the session, namely, the first Tuesday in October. Prospectuses and full particulars may be obtained on application to the Registrar, Imperial College, South Kensington, S W.7

APPLICATIONS are invited by Yale University for two Theresa Seessel Research Fellowships for the promotion of original research in biological studies, each yielding 300*l*. Preference will be given to candidates who have already obtained their doctorate, and have demonstrated by their work fitness to carry on

successfully original research of a high order The holder must reside in New Haven during the college year, ranging from October to June. Applications should be made to the Dean of the Graduate School, New Haven, Conn , U S A , before May 1 next, and should be accompanied by reprints of scientific publications, letters of recommendation, and a statement of the particular problem which the candidate expects to investigate

THE Royal Technical College, Glasgow, directs attention in its report for 1923 24 to the part taken by it for many years in the further education of adults The evening classes of last session were attended by 2587 adult students of ages ranging from twenty-one to seventy-five and, in addition, 546 enrolments were received for the " Elder " lectures on astronomy by Prof George Forbes on " The Old Astronomy and the New," and by the Rev E Bruce Kirk on " Stars in their Associations " The College maintained also its press campaign for informing the public of the important part taken by chemistry in the life and industry of the country, and numerous papers of a popular character were published by members of the staff on such subjects as the utilisation of waste, chemistry and wireless, etc

FROM the University of Leeds we have received a copy of the Council's annual report for 1923 24, which was issued on the eve of the Jubilee and " Coming of Age " celebrations of December 15-20 In it the Council announces, after summarising the serious and numerous present deficiencies in accommodation and equipment and in the provision for the social and athletic life of the University, that action is being taken to meet the most pressing requirements and to make the Jubilee year a starting-point for another period of progress. That they are able to do so is due in large measure to increased local aid. Grants from local authorities during the past year amounted to 30,000*l*., not counting the fees, amounting to 4500*l*., remitted to students as a condition of such grants The other chief sources of revenue were . endowments, donations, and subscriptions, 21,000*l*., parliamentary grants-in-aid, 58,000*l*., and fees for tuition, examinations, graduation, Students' Union, etc , 60,000*l*

THE December number of *The University Bulletin*, issued by the Association of University Teachers, contains an address by the president of the association, Prof Alexander Mair, on the significance of this organisation as marking a distinct phase in the evolution of the university system in Great Britain Among the many *éclaircissements* produced by the War were, Prof Mair says, the revelation to English people that in the universities they had a *national* asset, and a clearer awareness on the part of the universities themselves of their function and destiny. A " get-together " spirit took the place of particularism, and one of the indications of this was the appearance of the Association of University Teachers At present about 75 per cent of all the teachers in the university institutions of England and Wales belong to its 25 branches, although " Oxford and Cambridge are still hesitant, and their absence makes the one (an important) gap in an otherwise continuous front." In referring to the spirit of co-operation as between universities and the recognition of their value to the nation as post-War phenomena, Prof. Mair seems to have overlooked the fact that the first Congress of Universities of the Empire took place, and the Universities Bureau of the British Empire was constituted in 1912.

Early Science at the Royal Society.

January 10, 1662/3. Mr Howard mentioned a way of roasting in a very short time, with basting the meat with flames of lard poured upon it Dr Wilkins, that of boiling and stewing meat with lamps Mr Hoskyns, that of roasting many pieces of meat with a fiery globe of plated iron standing in the middle Sir Cyril Wyche, that of keeping water and other things warm in a double pot, separated by an interstice

January 11, 1671/2. Mr Isaac Newton was elected [Newton had written earlier " I am very sensible of the honour done me by the Bishop of Sarum in proposing me candidate, and which I hope will be further conferred upon me by my election into the society, and, if so, I shall endeavour to testify my gratitude, by communicating what my poor and solitary endeavours can effect towards the promoting philosophical design "]

1664/5. Sir Robert Moray mentioned, that the King had made an experiment of cold, with three glasses filled with sweet water, used for washing, one glass bigger than the other, taken out of a trunk by the King's barber, and freezing, after they had a very little while been opened, first at the top, and then with shootings of ice to the bottom, and so congealing together

January 13, 1663/4. The president acquainting the council, that Mr Hooke had discovered to himself, Sir Robert Moray, and Dr Wilkins, an invention, which might prove useful to England, and to the world, and that he had a good opinion thereof, but that it was necessary, that some experiments should be made for farther certainty, before it was made public which would require some charges not so fit to be put upon the inventor , it was ordered, that the President, Sir Robert Moray, and Dr Wilkins have power to employ any sum under ten pounds of the society's money for the said purpose

1669/70. Mr Oldenburg produced a manuscript sent and addressed to the president by Mr Flamstead of Derby, giving an account of some of the more notable celestial phenomena of the year 1670 to be conspicuous in the English horizon, among which was an eclipse of the sun visible in England, April 9, but omitted by all other astronomers The society declared that this was a very useful labour for the improvements of astronomy , and that therefore the author should receive their thanks by the secretary

January 15, 1661/2. Prince Rupert sent the society a description in High Dutch, of the method of making good gun-powder , which Mr Oldenburg was desired to translate, and Sir Robert Moray to return their thanks to his highness

1673/4. It being moved that Dr Daniel Cox having made many observations and experiments concerning the nature and figures of all sorts of salts, might be desired to impart them to the society, he was desired accordingly, and promised, that he would do so, after he had viewed and examined such salts by such a microscope, as had been approved of for its goodness by the Society · and a microscope being brought by Mr Cock to be examined, the trial of it was referred to a fitter time, it being then candle-light

January 16, 1667/8. Mr Oldenburg mentioned that he had received advice from Paris, that the person formerly said to have undertaken the translation of the " History of the Royal Society " into French, had not yet begun it, and was willing to forbear, upon notice sent him, that there was one in London, who would perform it And Dr de Molin being the person, who had undertaken that work in England, and now present, was desired by the Society to proceed in what he had begun with all possible care and diligence

Societies and Academies.

LONDON

Aristotelian Society, December 15.—L. J. **Russell**: Science and philosophy. Scientific investigation makes use of hypotheses, but something more is needed in the search for truth. The inquirer goes to Nature with demands which his own nature enjoins on him. Demands like hypotheses are anticipations, they say more than Nature tells, but they go beyond hypotheses, for they challenge Nature. Some demands are logical, some æsthetic, some metaphysical. Only legitimate demands can be satisfied, and we can only know what demands are legitimate by explicating the universe in detail by their help. There cannot be a view which is true in philosophy and in the end unworkable in science, or a view which is true in science and untrue in philosophy.

CAMBRIDGE

Philosophical Society, December 8.—C. T. R. **Wilson** and G. I. **Taylor**: The bursting of soap-bubbles in a uniform electric field. Measurements were made of the electric field necessary to burst a soap-bubble attached to a metal plate. The half-bubble correctly represents half of a complete bubble immersed in a uniform electric field. The instability is shown by photographs to take the form of a thin thread of fluid which is drawn off from the top of the bubble. The product (electric force) × (square root of radius) is constant at the bursting point. The maximum diameter of water-drop which can exist without bursting in a uniform electric field of 30,000 volts per cm. is 0·4 mm.—E. A. **Milne**: Dissociative equilibrium in an external field of force. The conditions of thermodynamic equilibrium in a gravitational field of heterogeneous substances capable of undergoing reversible chemical reactions, which were formulated by Willard Gibbs, are extended to include the case in which the products or reactants are associated with electric charges and may be subject to an external electric field. Application is made to the high-temperature ionisation of gases in stellar atmospheres.—T. M. **Cherry**: (*a*) Some examples of trajectories defined by differential equations of a generalised dynamical type; (*b*) Integrals developable about a singular point of a Hamiltonian system of differential equations. Part II.—J. **Brill**: Note on the Lorentz group.—E. H. **Neville**: Note on the harmonic conic.—R. **Hargreaves**: Thermodynamics and quantum theory.

DUBLIN

Royal Dublin Society, December 16.—H. H. **Jeffcott**: The theory of variation of flow in pipe lines with surge chambers consequent on variation of load on hydraulic turbines operated therefrom. The surge chamber, used with long pipe lines, acts as a supplementary reservoir near the turbines, so that the demand for increased discharge consequent on increase of load can be promptly met. This avoids the delay occasioned by the inertia of the great mass of water in the pipe, which requires some time for its acceleration, and also serves to relieve the pipes from water hammer consequent on the partial or complete closing of the turbine gates on reduction of load. The surge oscillations set up in the pipe line and surge chamber must not be allowed to persist for so long as to disturb the operation of the turbines unduly, and to this end a damping arrangement is often introduced. Equations are obtained for the motion of the water in the general case corresponding to any given law of opening or closing of the turbine gates, and approximate solutions are given.—Rev. H. C. **Browne**: The influence of the Fitzgerald contraction upon distance measurements and clock times. A real, absolutely existing Fitzgerald contraction underlies the relativity contractions indicated by the Lorentz formulæ, and the entire symmetry and equivalence of all systems in uniform motion of translation depend upon this real contraction resulting from the absolute undiscoverable movement of each system through space. The constancy of the observed velocity of light for each system, and the establishment of a consistent "timing" of events, common to all observers throughout a system, also depend upon this real contraction. Since all experimentally determined velocities, including that of light, result from some expression of the form $c' = l'/t'$, where l' is a fixed measured length and t' an observed interval of time, the value of c' will vary inversely with the value of t', but the product $c't'$ will have the fixed value l' independently of the rate of time movement. The same is true for $v't'$, and the ratio v'/c' will also be independent of the rate of time movement, provided that this latter is constant. In this way all expressions containing a problematic absolute value for c' and v' can be eliminated, and the concrete observed values $c't'$, $v't'$ can be substituted, *i.e.* velocities and times can be written down in the specialised form in which they must enter into any equation containing space co-ordinates. The form of the Lorentz transformations changes, but the mathematical contents remain identical.

PARIS.

Academy of Sciences, December 1.—Charles **Moureu**, Charles **Dufraisse**, and Marius **Badoche**: Auto-oxidation and antioxygen-action (XII.). Researches on the active auto-oxidisable form of acrolein.—Auguste **Bépal**: The fifth international conference of pure and applied chemistry, held at Copenhagen, June 16 to July 1, 1924.—Georges Claude was elected a member of the division of the applications of science to industry, in succession to the late H. de Chardonnet.—**Mordouhay-Boltovskoy**: The impossibility of an algebraical relation between π and e.—Bertrand **Gambier**: The polygons of Poncelet generalised.—Maurice **Gevrey**: The integration of the equation of dynamical tides.—E. **Huguenard**, A. **Magnan**, and A. **Planiol**: The measurement of the aerodynamical stresses supported by the wings of an aeroplane.—Jean **Boccardi**: Averaging by tenths of a year in variations of latitude. The usual method of taking the means of the values of the latitude, ϕ, by tenths of a year, has inconveniences and may lead to erroneous conclusions.—J. **Prédhumeau**: A new apparatus for the automatic construction of contoured maps by photographic restitution. An apparatus, named the "stereotopometer," is described, capable of giving maps with contour lines from photographs taken at the level of the ground. The method is purely optical, and this is claimed as better than the optico-mechanical methods previously described. The accuracy of the results is independent of distortion due to the photographic objectives.—Nicolas **Perrakis**: The thermodynamical interpretation of ionisation potential. The atom is transformed and equilibrium is maintained, due to the expulsion of an electron, the departure of which absorbs a quantity of entropy equal to C_1T, where C_1 is the thermo-electronic constant, $4{\cdot}07 \times 10^{-27}$ cal./deg.—A. **Dufour**: The distortion of an electromagnetic perturbation propagated along an insulated conducting line.—G. **Bruhat** and M. **Pauthenier**: The theory of electrostriction in insulating liquids.—Michel **Doloukhanoff**: The automatic regulation of the power of an electrical

installation. In an electrical installation composed of n machines of different powers, the number of combinations is $2^n - 1$, each working at or near its maximum capacity, and consequently with maximum efficiency Thus four dynamos of 100, 200, 400, 800 kilowatts will permit of the range 100 to 1500 kilowatts, in 100 kilowatt steps and with a favourable power factor The application of the same principle for other electrical machinery is outlined —— **Rateau** Remarks on the preceding communication The use of approximate geometric series —E **Carrière** and **Arnaud** Determination of the boiling-point curves and dew points of mixtures of hydrochloric acid and water under a pressure of 760 mm The experimental results are given in tabular and graphical form — J **Heyrovsky** Applications of the method of electrolysis with the mercury drop cathode —M N **Goswami** The direct hydrogenation and dehydrogenation of acenaphthene Sabatier and Senderens showed that their method of hydrogenation with nickel at 210°-250° C converted acenaphthene into tetrahydroacenaphthene, $C_{10}H_{10}\begin{matrix}CH_2\\|\\CH_2\end{matrix}$ If the temperature of the nickel is lower, 150° C, a mixture of tetrahydro- and decahydroacenaphthene is obtained, separable by fractional distillation If the vapours of acenaphthene, without hydrogen, are passed over nickel at 300° C, a good yield of acenaphthylene, $C_{10}H_8\begin{matrix}CH\\\|\\CH\end{matrix}$, is obtained — P **Lebeau** The presence of ethane in fire-damp from the Mines de Gagnières The presence of about 2 per cent of ethane together with traces of unsaturated hydrocarbons (0·04 per cent) in this fire-damp was proved The method followed was liquefaction at 215° C, with subsequent fractional distillation —Jacques de **Lapparent** The phenomena of sedimentation in the Cretaceous and Eocene strata in the Western Pyrences —I **Thoulet**. The liquid clouds of the ocean — Ph **Wehrle** and A **Viaut** The notion of interference in dynamic meteorology — L **Petitjean** The displacement of fronts of discontinuity —P **Martens** The cycle of the somatic chromosome in *Histera ovata* — K **Kvapil** and A. **Němec** The relation between the "absolute air capacity" and the degree of acidity of forest soils. The absolute air capacity, defined as the volume of the pores of the soil which, after saturating the soil with water, remain filled with air, is a physical property of fundamental importance as regards fertility The acidity, P_H, and the absolute air capacity have been measured for fifteen samples of forest soil, of which five were taken from forests containing conifers only, five from forests planted with deciduous trees only, and the remainder from regions planted with both —E **Rabaté** The action of dilute sulphuric acid upon fields of cereals Dilute sulphuric acid (4-10 per cent.), sprayed at a suitable stage of growth on growing cereals, has been proved to fertilise the soil, destroy weeds, check the action of certain parasites, and give an increased yield of 200 kgm to 300 kgm. of seed per hectare at a cost of less than 100 francs.—A **Policard** The phenomena of fluorescence determined in the tissues by Wood's light (radiations of wave-length 3650 Å) Application to the histology of the human ovary. Sections which appear uniformly white under ordinary daylight illumination, show differences of colour under the Wood light, indicating differences of constitution A detailed account is given of the application of this new histological method to the examination of the human ovary —P de **Beauchamp** The transmission of variation in rotifers of the genus Brachionus — Mlle France **Gueylard**. The influence of life in salt water on the development of the spleen in fishes In fishes capable of living in fresh and in salt water, a prolonged sojourn in the latter leads to a reduced development of the spleen —Léon **Blum**, Maurice **Delaville**, and Van **Caulaert** Modifications of the blood resulting from anaphylactic shock The method of ultrafiltration has been applied to the blood After anaphylactic shock, there is a marked increase in the proportion of calcium passing through the ultra-filter This effect is constant, and indicates a change in the protein colloid

CAPE TOWN

Royal Society of South Africa, October 15 — J S **Thomas** and W F **Barker** The partial pressures of water and sulphuric acid vapours over concentrated solutions of sulphuric acid at high temperatures (Preliminary note) The method adopted was the dynamical one of bubbling a carefully measured volume of air through acid at the required temperature and accurately determining the total quantity of vapour removed and also the amount of sulphuric acid contained in this vapour Only one concentration, 95 per cent, has been completely worked out Extrapolation of the total pressure curve to 760 mm gave the value 304° for the boiling-point of the acid, this compares favourably with the experimentally determined value 303°-307° —E **Newbery** On the application of the cathode ray oscillograph to the study of electrode phenomena (Preliminary note) The cathode ray oscillograph, supplemented with a thermionic valve, has been applied to the study of the single potential curves of a series of metallic cathodes in dilute sulphuric acid during make and break of the current through the cell Evidence of the existence of transfer resistance was obtained The direct method of measuring overvoltage cannot be relied upon in any circumstances, the commutator method gives true values only when extrapolation to infinite speed is carried out All the phenomena observed are readily explainable on the hydride theory of overvoltage —D F **Morrison** The pharmacological action of *Acokanthera spectabilis* The main action is on the heart, and is similar to that of digitalis The hour dose for frogs, and the minimal lethal doses for cats, rabbits, guinea-pigs, and rats show that the plant, which is indigenous to South Africa, possesses a high degree of toxicity There is a relative immunity on the part of the rabbit The plant contains glucosides. —M R. **Levyns** Note on some Peninsula plants. New or interesting plants from the Cape Peninsula

Official Publications Received.

Proceedings of the Royal Irish Academy Vol 36, Section A, No. 8 Corresponding Points on the Curve of Intersection of Two Quadrics By Dr A C O'Sullivan Pp 131-154 2s. Vol 37, Section B, Nos 1, 2, 3 The Colorimetric Estimation of Thiocyanates and Cyanates, by Dr Kenneth Claude Bailey and Mrs Dorothy F H Bailey, The Reaction between Ferric Chloride and Potassium Thiocyanate, by Dr Kenneth Claude Bailey, Freezing points of Solutions containing Ferric Chloride and Potassium Thiocyanate, by Dr Kenneth Claude Bailey and J D. Kidd Pp. 18 1s (Dublin Hodges, Figgis and Co., London: Williams and Norgate, Ltd.)

Memoirs of the Department of Agriculture in India Vol 18, No 4, Botanical Series The 'Mahali' Disease of Coconuts in Malabar By S. Sundararaman and T S Ramakrishnan Pp 87-97 (Calcutta Thacker, Spink and Co London W Thacker and Co.) 12 annas 1s

Transactions and Proceedings of the New Zealand Institute. Vol 55. Pp xviii+884+71 plates (Wellington, N Z: W A. G Skinner; London Wheldon and Wesley, Ltd.)

Conseil Permanent International pour l'Exploration de la Mer Rapports et Procès-verbaux des Réunions Vol 34, Procès-verbaux (Septembre 1924). Pp 60 (Copenhague: Andr Fred Host et fils.)

Memoirs of the Indian Museum Vol 5: Fauna of the Chilka Lake. No 18. On a species of Sub fossil Solitary Coral from the Chilka Lake. By Prof George Matthai. Pp. 897-903 (Calcutta Zoological Survey of India.) 1 rupee.

Proceedings of the Geologists' Association Edited by A. K Wells. Vol. 35, Part 4, December Pp 295-430 (London, Edward Stanford, Ltd.) 5s

Union of South Africa Department of Agriculture (Division of Chemistry Series No 31) Science Bulletin No 30 An Investigation into some Physical and Chemical Changes occurring in Grapes during Ripening By P R v d R Copeman Pp 38. (Division of Chemistry Series No 33) Science Bulletin No 32 The Composition of ripe Wine Grapes from the Government Viticultural Station, Paarl By G Frater Pp 30 (Division of Chemistry Series No 34) Some Methods of detecting Irregularities in the Composition of South African Wines By F Perrier, Pp 17 (Pretoria: Government Printing and Stationery Office) 3d. each

Department of the Interior United States Geological Survey. Water-Supply Paper 514: Surface Water Supply of the United States, 1919-1920. Part 12 North Pacific Slope Drainage Basins C Lower Columbia River Basin and Pacific Slope Drainage Basins in Oregon Pp v+204+2 plates. 25 cents Bulletin 756 Oil and Gas Fields of the Lost Soldier-Ferris District, Wyoming By A E Fath and G F Moulton Pp iv+57+8 plates 20 cents Bulletin 750-C Observations on the rich Silver Ores of Aspen, Colorado By Edson S Bastin Pp ii+41-62 n p Professional Paper 92 The Middle and Upper Eocene Floras of South-eastern North America By Edward Wilber Berry Pp v+206+65 plates 1 dollar (Washington Government Printing Office)

Department of Scientific and Industrial Research Report of the Food Investigation Board for the Year 1923 Pp iv+77+4 plates+14 charts (London H M Stationery Office) 3s net

Proceedings of the Yorkshire Geological Society New Series, Vol 20, Part 1, December Edited by H C Versey and Herbert E. Wroot Pp 154+v+12 plates (Leeds)

Committee of the Privy Council for Medical Research Report of the Medical Research Council for the Year 1923-1924 Pp 142 (London H M Stationery Office) 3s 6d net

Diary of Societies.

SATURDAY, JANUARY 10

BRITISH ECOLOGICAL SOCIETY (Annual Meeting) (at University College), at 10 A M.—Prof F E Weiss Plant Structure and Environment (Presidential Address).—Prof Oliver Blakeney "Far Point".—Prof Fritsch The Algæ of Swiftly Flowing Streams.—Prof Yapp: Deposition of Frost on Leaves

INSTITUTE OF METALS (London Section) (at Institute of Marine Engineers), at 7.30.—Dr R H Greaves Extensometers

MONDAY, JANUARY 12.

ROYAL IRISH ACADEMY, at 4.15

ROYAL SOCIETY OF EDINBURGH, at 4.30.—E L Gill The Permian Fish Dorypterus.—E A Baker The Blackening of the Photographic Plate at Low Densities.—Dr E L Ince The Modes of Vibration of a Stretched Membrane with a particular Law of Density

INSTITUTE OF TRANSPORT (Yorkshire Local Section) (at Town Hall, Leeds), at 5.30.—J B Hamilton Inaugural Address

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Merchant Venturers' Technical College), at 6.—W B Woodhouse: Presidential Address

INSTITUTION OF AUTOMOBILE ENGINEERS (at Chamber of Commerce, Birmingham), at 7.—Dr S S Pickles The General Manufacture of Rubber (Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W Day and others Discussion on Telephonic Development in Great Britain and in the United States

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle on Tyne), at 7.15.

INSTITUTE OF METALS (Scottish Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Open Discussion

SURVEYORS' INSTITUTION at 8

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major R W G Hingston Animal Life at High Altitudes.

INSTITUTE OF BREWING (at Engineers' Club).—J Stewart: The Season's Barleys

TUESDAY, JANUARY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A Fowler: The Analysis of Spectra (1)

INSTITUTION OF MECHANICAL ENGINEERS (South Wales Branch) (at Swansea), at 6.—A A Fordham Steel Construction as applied to Steel Works and Mill Buildings

INSTITUTION OF CIVIL ENGINEERS, at 6.—Prof A H Gibson The Investigation of the Surge-Tank Problem by Model Experiments.—F Heywood The Flow of Water in Pipes and Channels.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—Dr. S. S Pickles The General Manufacture of Rubber (Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—W B. Woodhouse Presidential Address

MANCHESTER METALLURGICAL SOCIETY (at College of Technology, Manchester), at 7.—F C H Lantsberry. Tool Steels.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A S Watson: Portraiture of Men

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates Meeting) (at Broadgate Café, Coventry), at 7.15.—A E. Barrett: Piston Rings.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham Section) (at University), at 7.15.—H. L Heathcote: The Testing of Resistance to Tearing.—D. F Twiss and F Thomas A Comparative Study of some Vulcanisation Accelerators.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30

INSTITUTE OF METALS (North East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—A. R. Page: Blazing.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—S. R. Wycherley: The Mounting of Chemicals for the Polariscope.

ROYAL SOCIETY OF MEDICINE (Psychiatry, Neurology, Disease in Children, and Epidemiology Sections), at 8.30.—Dr. P C P. Cloake and Dr F C. Shrubsall (Psychiatry), Prof. E. Bramwell (Neurology), Prof A Hall (Disease in Children), Dr. McNalty and Dr Parsons (Epidemiology), and others. Discussion on The Mental Sequelæ of Encephalitis Lethargica

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Section).

WEDNESDAY, JANUARY 14.

ROYAL SOCIETY OF ARTS, at 3.—Lt Col. G M Richardson: Dogs in Peace (Di Mann Juvenile Lectures)

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. V Coates Clinical Types of so called Infective Arthritis

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—S Ward Some Notes on Short Wave Reception

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 7.—H J Deane and others Discussion on The Use and Abuse of Reinforced Concrete

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—H W. Taylor Three Wire Direct-Current Distribution Networks Some Comparisons in Cost and Operation

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on Tyne), at 7.—J Calderwood Propeller Design

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Annual Meeting

THURSDAY, JANUARY 15

ROYAL SOCIETY, at 4.30.—Sir Charles Sherrington and E G T Liddell Further Observations on Myotatic Reflexes.—Prof A V Hill, C N H Long and H. Lupton Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen Parts I. II, and III.—Prof A P Chattock The Physics of Incubation.—H M Carleton Growth, Phagocytosis, and other Phenomena in Tissue Cultures of Fœtal and Adult Lung.—J. F Fulton (*a*) The Influence of Tension upon the Electrical Responses of Muscle to Repetitive Stimuli, (*b*) Some Observations upon the Electrical Responses and Shape of the Isometric Twitch of Skeletal Muscle, (*c*) The Relation between the Durations of the Isometric Twitch and of the After action of Tetanus.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—J S Huxley: The Courtship of Animals and its Biological Bearings (1)

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates Meeting) (at Watergate House, Adelphi), at 7.30.—A E L Colline: Steam Vehicles for Road Transport

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—A Steavenson A Peep into Sir William Herschel's Workshop

CHEMICAL SOCIETY, at 8.—E. E. Turner and A B Sheppard. 6-Chlorophenoxarsine.—G A R. Kon and R P. Linstead The Chemistry of the Three Carbon System. Part III. $\alpha\beta$-$\beta\gamma$ Change in Unsaturated Acids, Part IV A Case of Retarded Mobility

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Lt.-Col A T Gage and Lt Col. Clayton Lane: The Alkaloids of Cinchona and Malaria

INSTITUTION OF RUBBER INDUSTRY (at 16 St Mary's Parsonage, Manchester).—J. Adamson: History of the Rubber Industry in Manchester

FRIDAY, JANUARY 16.

ROYAL SANITARY INSTITUTE (at Town Hall, Newcastle on-Tyne), at 4.—Dr A F. G Spinks, H. H. Evers, and others Discussion on Maternity and Child Welfare Practice

ROYAL DUBLIN SOCIETY, at 4.30

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7

INSTITUTE OF METALS (Swansea Section) (at Swansea University College), at 7.15.—Prof C A Edwards. Alloys and their Properties

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Major A M. Taylor. The Hexaphase System and the Compensated 3 Phase System for 150,000 Volts Transmission with Records of Test.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cathays Park, Cardiff), at 7.30.—T. Lewis: Chemical Constituents of Ductless Glands.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group jointly with the London Section) (at Royal Society of Arts), at 8.—T. W. Stainer Hutchins, Dr. C H. Lander, and others Discussion on The Low Temperature Treatment of Bituminous Materials

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 8.—Sir Max Muspratt, Bart. Chemistry and Civilisation (Hurter Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: The Investigation of the Properties of Thin Films by means of X-Rays.

PUBLIC LECTURES.

WEDNESDAY, JANUARY 14

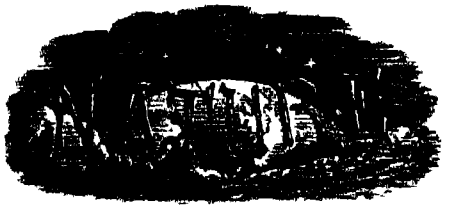
LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—B. J. Fletcher. The Principles of Design (Introductory Lecture).

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE (Physiology Department, 6 Giltspur Street, E.C.1), at 5.—Prof. C. Lovatt Evans: The Physiology of Plain Muscle. (Succeeding Lectures on January 21, 28, February 4.)

KING'S COLLEGE, at 5.30.—Prof. A P. Newton: The World of the Middle Age.

THURSDAY, JANUARY 15.

UNIVERSITY COLLEGE, at 2.30.—Miss Margaret A. Murray. Egyptian History (Introductory Lecture).



SATURDAY, JANUARY 17, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Research in Agriculture.

ALTHOUGH the Development Commissioners are not themselves directly responsible for agricultural education and research during the last fourteen years, the manner in which the funds subject to the jurisdiction of the Commissioners have been portioned out has exercised a dominating influence on both the quality and quantity of scientific information that has been recently acquired, and on the nature of the organisation by which it has been sought to render this information of immediate assistance to the farmer. If the fourteenth Report of the Development Commissioners (H.M.S.O., 4*s* net) is read in conjunction with the first and later reports, it will be noted that the Commissioners have favoured and adhered to a more or less definite policy from the outset. They realised that one of the primary needs was to assist in the training of men competent to conduct research, and then to accelerate research on the fundamental problems underlying agricultural practice. The body of scientific men at present employed in connexion with agricultural science is to-day vastly greater than it was fourteen years ago, and it is probably not too much to say that the average training which these men have received, and also the attainments and qualifications of the average man, are decidedly better.

It has been the policy of the Commissioners to add to the volume of research, chiefly by assisting in the initiation and maintenance of Research Institutes and Experimental Stations, and there are now about twenty such stations in Great Britain dealing with fundamental problems. It is interesting in passing to note that the necessity of having more than one institution to deal with certain problems which have specially local application has now been realised and acted upon, thus England, Scotland, and Wales has each a Plant Breeding Station aided by grants from the Development Fund, while the needs of horticulture, for example, are recognised at more than one institution.

The Report before us affords ample evidence of the quality and quantity of the research in progress at these institutions. It is beyond the scope of the present article to attempt to review this work. It is necessary, however, to lay emphasis on its fundamental character, the vast majority of the scientific papers for which the staffs of the institutions have been responsible dealing with difficult problems approached in an exhaustive manner and by purely scientific methods. There can, in short, be not the least doubt that the policy of the Development Commissioners has been successful to a marked degree in two highly important directions. To-day we have, comparatively speaking, a large, and in the main a well-qualified, body of agricultural scientific workers, and a vast mass of accurate scientific

data of great potential value to the farmer and to the nation. No reasonable criticism can be levelled against the Commissioners for the manner in which the funds have been apportioned in relation to solving the problems of the various branches of the industry, although to some it may appear that horticulture has been treated more generously than would at first sight seem to be justified by its position in Great Britain. It has, however, to be realised that horticulture is an intensive industry employing a considerable amount of labour, and thus any extension of fruit culture or market gardening must immediately and inevitably react in a favourable manner on the rural population.

It is obvious that science cannot of itself redeem an industry which is in the main under-capitalised and very largely unprofitable It should, however, be equally obvious that if the conference of land-owners, farmers, and land-workers recently convened by the present Government can in fact agree on a sound agricultural policy at once far-sighted and acceptable to the nation as a whole, the ultimate success of that policy will be largely determined by the extent to which science is brought to the direct aid of the farmer. It is, therefore, legitimate to examine the organisation which exists to-day for the explicit purpose of bringing science to the direct aid of the farmer, and to do so in the light of what are considered to be the chief necessities of British agriculture, if this industry is to be regarded as of national importance as well merely as of something which concerns the well-being of what is no inconsiderable proportion of our population.

The Commissioners have, of course, realised the necessity of a connecting link between the Research Institutions and the county organisers who are primarily responsible for advising the farmer as to scientific practices. Advisory officers are now attached to fourteen institutions; the majority of these are, however, advisory chemists and pathologists whose chief preoccupation in most cases is to undertake research on laboratory lines into problems of local importance, and in the main they have not the facilities to investigate farm practices as such. It is therefore satisfactory to note that Advisors in Economics are now being appointed at some of the institutions, and the work already done, notably at the University of Leeds, would seem to indicate that, particularly when the officers devote their attention to the economics of local practices, they are able to afford signal service to the farmers within their areas. Recent results obtained at the Research Institutes in the realm of animal nutrition have been followed up at college farms by accurate feeding trials, so that it is now possible for organisers who have had the opportunity of gaining personal experience to give authoritative advice to individual farmers, which has in innumerable cases revolutionised the system of feeding adopted. In this connexion the pioneer work of Mr. Boutflour in Wiltshire affords one of the best recent examples of the way in which science has been brought to the direct and very substantial aid of the farmer, and has incidentally caused increased production, in this case in terms of gallons of milk. It is perhaps open to doubt, however, whether science has been brought sufficiently to bear on some of the wider and more national aspects of agriculture in Great Britain.

Mr. Edward Wood, the Minister of Agriculture, in recent speeches and referring to the conference of those concerned in the industry he has convened, has emphasised the need of adding to the area under cultivation in Great Britain, not necessarily by merely thinking in terms of wheat alone, and he has directed attention to the paramount need of making our more derelict lands fertile and this whether particular areas are left in grass or brought under the plough. Mr. Wood has also directed attention to the serious disadvantage under which the farmer labours in regard to bringing his farm into a higher state of fertility as the result of paucity of readily available working capital.

Broadly stated, then, one of the first necessities, if we are to have a healthy agriculture, is a campaign of land improvement in the widest sense, and from the facts of the case, no matter whether credit facilities are to be afforded to the farmer on a large scale or not, the improvements must be effected on an economic basis.

Here, then, is a concrete, yet highly composite problem, a problem towards the solution of which agricultural science has admittedly accumulated a vast array of data But the items contributing to such data are largely unrelated and cannot at present be said to constitute a definite and trustworthy practical doctrine.

The allied questions of improving poor land and generally enhancing the fertility of farm lands in Great Britain as a whole are not subjects upon which the organiser can easily persuade the farmer himself to experiment. The problems involved entail, first, difficult economic considerations, and secondly, the elucidation of practical difficulties connected with the type of rotation and systems of cropping most suitable, methods of tillage, processes of manuring, relation of grass to arable, and the choice of the correct varieties and strains of crops. The general problem is not, moreover, one that is likely to be adequately dealt with at an institutional farm; for one thing, these farms are frequently of a higher grade than the average of the district which they represent, and for another, it is usually the policy to run such farms in conformity with the generally accepted canons of good husbandry.

Indirectly, valuable work has been accomplished in

the direction of surveying the field by the various soil and other surveys that have been undertaken. Hitherto, however, no large sum of money has been set aside for this important work, which has been conducted in a somewhat haphazard manner and in many cases without critical regard to economic considerations. In any event, it is work that needs to be conducted on a well-thought-out and uniform plan, under the general supervision of a strong co-ordinating authority. The need of a complete agricultural survey showing both actualities and potentialities was rendered abundantly manifest during the War, while if a real endeavour is to be made to stabilise the industry and add to the productive capacity of farm lands in Great Britain, the non-existence of such a record will again be acutely felt.

In so far as growing the correct varieties of the chief crops is concerned, it is satisfactory to learn that a grant has been made to the National Institute of Agricultural Botany to enable that organisation to conduct subsidiary trials at carefully selected sub-stations. It is, however, on the poorer and more improvable types of land that variety trials are most needed, while in many cases the type of varieties necessarily handled by the National Institute are not likely to be those best suited to land of the lower productive classes. Trials of a somewhat different nature should also be initiated; the aim in the first place would be to discover the degree of productivity of every characteristic district, by setting up a series of properly replicated plots of the same standard variety—of a crop of wide-spread distribution such as oats—on as many farms as possible.

This is a procedure that should constitute an important feature of any general scheme of agricultural survey that may be set on foot, for without some really trustworthy quantitative and easily comparable crop data of this sort it is difficult to see how the results of surveys based on soil and other environmental factors can be interpreted to proper economic advantage. In the second place, it is exceedingly important to know the range of applicability of new and improved varieties, and it is just as important that the greatest possible number of farmers should be given the opportunity of forming their own opinion of such varieties.

With a view to these ends quantitative data are not necessary, or at all events not necessary in the first instance. A strip of, say, Yeoman wheat should be sown on a few fields in every parish in the country in which wheat, in no matter how small quantity, is grown. The same would apply to, say, Black Bell III. and Victory or Crown oats, while in particular districts it would be easy for the appropriate advisory centres to make proper suggestions as to varieties demanding extensive trials by this means. A similar simple method would make it possible rapidly and accurately to define the areas capable of successful lucerne cultivation, to establish the relative merits of widely different strains of such a fundamentally important crop as red clover for widely different habitats. All of these are problems of first-rate importance in relation to profitable land improvement.

More urgent than trials of the character indicated above is the necessity for conducting experiments in the realm of systems of cropping, and the relation of temporary to permanent grass, which would entail equally far-flung but more elaborate and long-continued field trials.

It is true that financial support has been given to further the idea of arable dairy-farming, and that the utilisation of barren sandy land has been under tentative investigation, but these are isolated aspects of the broad question of enhanced crop production and land improvement. They are not so much the province of agricultural chemistry or of agricultural botany as understood in Great Britain, but rather of field husbandry or agronomy as understood and investigated in the United States of America, for example

Notwithstanding the work that is in progress in many important directions influencing land improvement, it is probably not too much to say that the problems of field husbandry will not be solved until an *ad hoc* organisation is set up to deal with the matter in a manner analogous to that in which the Research Institutions deal with the fundamental problems of plant breeding and animal nutrition, for example, or the way in which the advisers in agricultural chemistry deal with their local problems It is doubtful, however, if a single Research Institute of field husbandry would adequately meet the case—numerous sub-stations would certainly be a necessity. It is, however, the principle that field husbandry is not at present a matter of demonstration, but is essentially a matter demanding field investigation of a most rigorous and accurate character, conducted without bias and in a true spirit of research, that must be realised Two things are essential, namely, a co-ordinating authority and the appointment of men in the counties backed with facilities for conducting field investigations on carefully selected areas. A useful beginning could undoubtedly be made if advisers in field husbandry were appointed at institutions serving backward and infertile districts, while co-ordination could be assured by the appointment of an officer at the Ministry of Agriculture charged with the supervision of the work as a whole. It is probable that in some cases suitable land could be taken over for experimental purposes from the not inconsiderable areas now under the control of the Forestry Commission, while it is more than likely that land-owners and farmers would be found in very appreciable numbers who would be willing to assist in such an important undertaking.

Human Geography.

Human Geography. an Attempt at a Positive Classification—Principles and Examples By Jean Brunhes. Translated by Prof. I. C Le Compte. Edited by Isaiah Bowman and Prof Richard Elwood Dodge. Pp. xvi+648 (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., n d.) 21*s.* net

THE student of modern geography by whom this classical work is read for the first time, might well feel that even in the few years, little more than a decade, since the original issue, most of this manual has become, if not out-of-date, at least somewhat antiquated A youthful applicant for a situation was asked "Where is Tokyo?" He replied, "I do not know." The employer expressed his astonishment in vigorous terms, and the youth continued, "But if you will tell me where it is, I will tell you why it is there." This youth was a product of his period, the geography of to-day seeks to answer the question "why?" The aim of modern geography is to probe, to evolve generalisations, to eliminate and thus simplify complex phenomena in which the psychological factor is of supreme importance.

M. Brunhes provides a useful corrective He writes and argues about what he has seen; he aims at a manual, not a treatise, at a collection of observed facts, not an explanation. Again and again he advises caution. The fundamental fact is place-relation, and he shows repeatedly how every thinker whose subject-matter implies some form of human activity needs the geographic sense. The Ricardian law of diminishing returns does not apply where the land, as such, is not the fundamental basis of property. Again and again the reader is referred to six essential facts: houses and roads, cultivated fields and domestic animals, exploitation of minerals and devastation in plant and animal life —facts familiar enough under a slightly different grouping of ideas in the terms shelter, food, and communications

By numerous illustrations and digressions the reader is led to an idea of geographic method, to a manner of attack upon a seemingly heterogeneous collection of an apparently endless mass of isolated facts, and the whole outlook may be summarised under the query "how?" not "why?" A heavy snowfall is to be expected in January in New York and other places where the mean January temperature is about, or below, freezing point. The "why" of this fact belongs to the domain of physical science: the recognition of the fact as a possible factor in regard to man's life on the earth belongs to physical geography. So far everything is simple, but the human geographer asks the question how is man affected? It is his business to find out how man reacts to this circumstance, and he finds widely different answers for different parts of the world. The response in New York is different from the response in Italy, and so he arrives at the fundamental concept of location, the tyranny not of Nature as a whole but of place-relationship within Nature.

M. Brunhes is deliberately didactic; he teaches by selected samples and begins with the simplest examples. The easiest studies refer to islands—not only the real islands of the sea, but also the land islands where a community is relatively isolated by physical circumstance; his study of the Balearic Isles leads to thoughts about Java or Japan. Herein, it would appear, lie the elements of age which might repel the modern student, for there is little consideration of the world as a whole; there is no room for the current broad generalisations which underlie the idea of the "major natural regions of the world." A regional synthesis, however, is not lacking. A map of Spain, for example, shows within the area of dry Iberia five regions of steppes and irrigation, and so illustrates a regional classification based, not upon the facts of climate, but upon the ways in which man has responded to one particular element, water supply.

In the last chapter it is argued that space, distance and difference of level are fundamental geographical facts which are becoming more and more the sovereign masters of men, and the final conclusion is reached that "Every people . . . covers the surface of the earth with those outward and visible signs . . . which allow us to divine its past and sometimes even its future." Whither does all this lead? Apparently to the notion that geography is not a science, not an ordered body of knowledge, which is independent of the personality of the investigator, not a set of conclusions which must be universally valid, not a statement of generalisations valid for all time or for every place, but primarily and fundamentally a discipline, an outlook on man's life on the earth, which gives to the thinker that unique geographic sense so invaluable for the law-maker, the captain of industry, and the merchant prince, so useful a corrective in all matters which pertain to the conduct of human affairs on the large scale.

Whatever view may be taken, it must be confessed that the facts of geography are stubborn; they cannot be melted in the mental furnace and run into set moulds; they frequently misfit the theories; but the spirit of geography is of unique value. No other human study permeates so many of the sciences; no other study is so necessary to the equipment of the educated man.

Optical Measuring Instruments.

Optical Measuring Instruments, their Construction, Theory, and Use By Dr. L C Martin (Applied Physics Series) Pp. ix+270+8 plates (London, Glasgow, and Bombay: Blackie and Son, Ltd, 1924) 17s 6d. net.

"OBTAIN a measurement, however rough; then endeavour to get a better," was the advice that Lord Kelvin used to urge upon his students Quantitative analysis is the natural supplement of qualitative reasoning One rough estimation may serve to exclude a multitude of suppositions, one precise measurement may serve to indicate the definite conclusion of an investigation. But to make a measurement, even an approximate one, is not always easy Precise metrology is a difficult art It demands an understanding of the problem, access to the requisite apparatus or, failing instrumental means, the capacity to design and, if necessary, construct whatever appliances may be required; skill in their adjustment and use; and, above all, the will to discard the obvious, which in metrology is not always the truth

As there is no superfluity of literature devoted to this particular subject, any new contribution, such as Dr. Martin's work on "Optical Measuring Instruments," will surely be welcomed As the author has stated in his preface, "The selection of instruments for description is extremely difficult" It is unlikely, indeed, that from the great mass of material that is nowadays available the same selection would be made by many. With the exception of Chap vii. devoted to rangefinders, it would appear that instruments of warfare have intentionally been rigorously excluded All the appliances cited have an essentially peaceful character. They comprise measuring microscopes, micrometers, comparators, the divided circle, theodolites and sextants, levels, spectrometers, refractometers, spherometers, focometers, photometers, and saccharimeters. In the final chapter, "Errors and Accuracies of Observation" are discussed rather more briefly than the importance of this question would warrant.

There is a similar brevity in the presentation of the general principles forming the subject of the first chapter, where the author in his discussion of the principles of geometrical supports is to be congratulated upon his emphasis on the importance of the physical conditions. These first and last chapters might well have been extended at the expense, if necessary, of other sections. For example, although the divided circle is a highly interesting precision tool, it is scarcely an optical instrument when stripped of its reading microscopes, which are dealt with in the preceding chapters. Rangefinders, which are essentially militaristic in character and of correspondingly limited interest, might also have been excluded, if thereby space could have been provided for a chapter upon that premier optical instrument of supreme accuracy—the interferometer, which has been brought in Great Britain to so high a standard of perfection. The chapter on the rangefinder, and particularly the stereoscopic portion, is the least satisfactory section of the book Evidently the author is unaware that the German claim which he emphasises on p 121 has been disproved beyond doubt as the result of extensive trials made by most of the principal powers interested in this subject, and that many important gunnery officers of the German Navy no longer accept it

Dr Martin's book has the merit of originality It is not a compilation from other works Originality in a first edition demands, however, particular care in the avoidance of errors, and unfortunately there are throughout this book mistakes of so obvious a kind that it is difficult to understand why they should have escaped correction. In Fig 45, which illustrates the application of an inverting prism to a sextant, the rays are quite incorrectly traced, as they are not shown touching the reflecting surface which determines the inversion of the image All three diagrams of Fig 93 are also incorrect. A ray normal to the surface of the prism (*a*) is shown refracted. In the next diagram, representing the same prism, the ray entering as before at scraping incidence is now shown refracted away from the base, the refracted ray within the dense flint prism being shown in an impossible position. According to Fig. 93 (*c*), a beam of light passing through an equivalent plane parallel plate is wrongly represented as suffering severe refraction instead of emerging parallel to its original direction

The mistakes are not confined to the illustrations: they occur also in the text As an example, the "special problem in angular measurement" at the end of the chapter on theodolites and sextants may be cited. The problem indicated is to measure the inclination of two lines It is proposed, instead of suitably rotating the cross-wire of a telescope with reference to the lines and a scale, to make use of a rotatable inverting prism As the author states, if such a prism is rotated about the direction of view, the inverted image rotates at twice the angular speed of the prism, and the conclusion is arrived at that greater accuracy of measurement is attained by these means. But, as the problem is the measurement of a particular angle, the prism will require to be rotated through only half the angle to be measured, and the comparative accuracy will accordingly be halved.

Although the majority of the mistakes are obvious ones, they may prove confusing to a thoughtful student, and more careful revision, particularly of the illustrations, is desirable in any future edition of the work.

JAMES WEIR FRENCH.

Sands and their Uses.

Sands and Crushed Rocks By Alfred B Searle. (Oxford Technical Publications) Vol. 1. *Their Nature, Properties and Treatment.* Pp xiv + 475 Vol. 2 *Their Uses in Industry.* Pp ix + 281. (London Henry Frowde and Hodder and Stoughton, 1923) 52*s* 6*d.* net.

MR. SEARLE has made an attempt to fill a gap in technical literature by a work which deals, in all aspects, with the subject of sands and crushed rocks According to the author, the purpose of the work is "to summarise in a convenient form such geological, chemical and mineralogical information on sands as is likely to prove of value to those engaged in the digging, sale, and many uses of these materials." To the reviewers, however, it seems that the author's enthusiasm for detail, much of which appears irrelevant, has defeated this purpose

A glance at the table of contents will reveal the varied nature of the material gathered together in Volume 1 Commencing with the origin and formation of sands, we finish with a chapter on their storage, packing and despatch In Chap. iii, ninety pages are devoted to a catalogue, arranged in alphabetical order with descriptive detail, in which names are given to nearly one hundred and fifty sands! For no obvious reason, a description of a carborundum furnace is here included Incidentally, there seem to be but few substances which, according to the author, do not come within the purview of this subject. For example, ground glass and metal filings are stated to have been used as "sands" in concrete, while "breeze" is described as an artificial sand consisting of sifted ashes The writer has departed considerably from the customary definition of a sand as a natural, detrital and non-plastic deposit. Chap iv, written on similar lines, deals with some of the mineralogical constituents of sands, while in the next two chapters their properties, as well as their examination and testing, are described

The remainder of this volume is concerned with the treatment which sands and sand rocks undergo before use It is profusely illustrated, but many of the photographs are reminiscent of the advertisement catalogue.

The second volume of the work enlarges upon the uses of sands and crushed rocks in industry. The uses of these materials in brick-making, in road construction, as refractory materials, in agriculture, in glass-making and in metallurgy, to mention only a few of the more important applications, all receive attention.

Many statements to which exception may be taken seem to have escaped the author's notice. For example, Stokes's law is first written as $V = \frac{2D - d}{9^2}$ and then quoted correctly on the next line. Referring to the constant weight obtained when a material has been fully dried we find the statement that "this weight, less that of the bottle and contents previous to drying, is the amount of moisture in the weight of materials used." In connexion with electrostatic separators, we are told that "a still more definite separation will take place if the whole of the material is first charged negatively and is then brought into contact with a positively charged body," while it is also stated that the "mean coefficient of expansion of silica between 0° C and 1000° C. is 0 68" Again, the figure on p 437 (I) given in illustration of a "gas-fired" furnace does not represent a gas-fired furnace Finally, we are told that "a tunnel-kiln efficiently insulated with kieselguhr on the sides and roof can usefully employ 98 per cent. of the available heat in the fuel."

Elsewhere, there becomes apparent a certain looseness of style, and this gives rise to statements which may be ambiguous or often misleading. For example, the refraction of light is described as the *turning* of a ray of light, while on p. 208, Vol. 1, it is explained that doubly refracting materials "turn a ray of white light through several different angles, so that the rays are termed ordinary and extraordinary rays."

Moreover, the book contains inconsistencies, one example of which cannot be allowed to pass unnoticed. "Tridymite bricks are silica bricks in which the whole of the silica has been converted into tridymite. . . . No brick on the market consists entirely of the low specific gravity forms of silica"

The breadth of field which the subject covers, the inaccessibility of many publications, and considerations of space, are put forward in the preface as a plea for the omission of full references. But surely the time has come when few technical or scientific works, other than the most elementary, can stand the test of publication without the support which adequate references to the literature of a subject gives. The necessary space could have been gained by the elimination of much of the unnecessary matter and by avoiding repetition.

A judicious selection of the references the author must have accumulated during the many years in which, as he tells us, he has read the leading journals

on the subject, would undoubtedly have enhanced the value of this book and been of permanent worth

The volumes are well printed and well presented, but the price is high, and the author would have done well to have compressed his subject-matter into a smaller space. Doubtless much useful information will be found, especially in the second part, by those for whom the author has written, but the gap in the literature still remains L S. T
W. E

An Oxford Sketch of the Evolution of Thought.

Speculum Mentis, or the Map of Knowledge By R. G Collingwood Pp 327 (Oxford · at the Clarendon Press, 1924) 12s 6d. net.

MR COLLINGWOOD has a tradition of art behind him and he has also made himself recently one of our leading authorities, if not the first of all, on Roman Britain As he adds to this a profoundly philosophic mind, his attempt in this book to survey the whole field of human thought has some material for its foundation It is modest in expression though ambitious in scope, and will interest greatly those who like to trace a line of thought faithfully pursued by a thinker who wrestles hard with every conclusion, and gives the public nothing but what he has won from his own experience, intensely felt

The general thesis of the book is that the human mind, whether in the individual or in the race, passes through a series of experiences each of which is incomplete and partially corrected by the succeeding stage, until it rests at last in a philosophy of absolute or final worth based on the mind itself, enlightened by history It will be seen that there is a large heritage from Hegel here, and if one wished to describe the point of view in terms of older thinkers who have influenced the writer, one would say that it was Hegelianism plus Croce But this would do scant justice to Mr Collingwood's sincerity of thought and striking individuality. One appreciates the book most as a personal revelation.

Art is the first, and always the primitive, stage of thought; and this passes into the kindred, concrete and unanalysed stage of religion Analysis, when it comes, gives us science, which appears in Mr Collingwood's hierarchy of thought as the middle term. Art and religion are below or before it · history and philosophy above or after. We are not to imagine that the lower stages are entirely superseded by the higher; they are rather corrected and subsumed in a fuller point of view.

The use that Mr. Collingwood makes of the recent historical spirit in science is very apt and enlightening. It is the clearest and most conclusive part of the whole book. During the nineteenth century many of the sciences, as he tells us, restated their problems in terms of history Astronomy realised that its proper task was to explore the history of the stellar universe; geology and geography united to study the history of the earth, and biology came to see that the problem of species is the problem of the origin of species "The time seems near at hand when science will feel the need of absorbing itself bodily in history and re-shaping its problems throughout in historical terms."

This passage from science to history is one of the numerous points in the book where a penetrating light is thrown by the author's synthetic and persevering thought He might perhaps have made his effect better by a little more compression There is a good deal of repetition, and the reader himself needs perseverance, but he will be richly rewarded It is one of the most profound and suggestive treatises of recent years F. S MARVIN.

Our Bookshelf.

The Design and Working of Ammonia Stills. By P Parrish Pp 300 (London. Ernest Benn, Ltd., 1924) 40s net.

THREE hundred thousand tons of ammonium sulphate are produced annually in Great Britain by the direct distillation of the ammoniacal liquors arising from coal and shale products Even from this consideration alone, the publication of the first standard comprehensive book in English on the design and working of ammonium stills must be regarded as an event not only of scientific but also of economic importance. Many chemical manufacturers in the past for various reasons have endeavoured to keep their processes strictly secret, and improvements have come from internal experience on the plant rather than from general physico-chemical considerations or from a combined study of the theoretical and applied aspects of the problem or difficulty encountered "Collaboration," Dr Charles Carpenter notes in the preface, "between those responsible for the design of large-scale chemical plant can only be a war-time measure" Mr. Parrish will help to some extent to remove in one industry this individual outlook and veil of secrecy, for in his book he has collected together a great amount of novel information of a fundamental and authentic character on the subject of ammonia stills and accessory plant This carefully-edited book, which includes 170 excellent illustrations and 70 technical tables, must benefit the industry generally and secure a common outlook for new developments on other than empirical lines

It is indicated that the greatest economy in the manufacture of ammonium sulphate is likely to accrue from a better utilisation of the available heat of the process, and the aim of the author has been to show how this can be achieved. In fact, so keenly has the point been emphasised that the volume might be

called the design of ammonia stills in relation to steam economy and the utilisation of potential heat The fundamental principles underlying the design of stills, preheaters, condensers, dephlegmators and coolers all receive thorough consideration in this connexion The opinions put forward are those of a successful works' chemist who writes more particularly for the benefit of other gas chemists and engineers rather than for the guidance of the chemical student

A note of criticism might be made on the general use of chemical formulæ in a somewhat loose manner, while the chemical equations given are not always correct.

In conclusion, it should be stated that the financial aspect of the subject of ammonia distillation also receives detailed treatment, and the author makes every effort to indicate the economic soundness of processes under particular conditions

JOS. REILLY

The Subject Index to Periodicals, 1921 Issued by the Library Association. *B-E · Historical, Political and Economic Sciences.* Pp 106. 21*s* net *F Education and Child Welfare* Pp. 28. 4*s* net. (London: Grafton and Co , 1924)

WE welcome these two sections of the Subject Index to Periodicals published by the Library Association. They maintain the high standard attained in previous sections of this catalogue. These sections index papers published in 1921, so that the Association is now allowing a little less time to elapse between the date of publication of the original papers and that on which the Subject Index is issued. It would, of course, be more useful to those engaged in scientific work if it were found possible to shorten the interval to somewhat less than three years, and the Library Association will, no doubt, when it has overcome all the difficulties connected with a work of this kind, find it possible to issue its Indexes within a period of two years from the date of publication of the periodicals indexed

Among those subjects in the section on historical, political and economic science to which particular attention has been paid we notice agriculture, banks and banking, bolshevism, chemical manufacturers, coal trade, co-operation, the Eastern question, employees and employment, ethnology, the European War, fisheries, forestry, international law, labour, mines, railways, shipping and wages.

The section on education and child welfare will be of great value to those who are devoting themselves to the study of these subjects. An examination of the 54 columns of titles of papers in this section will show the direction in which the thoughts of those advocating reforms have been chiefly turned. We note especially educational psychology and mental tests, and papers on the position of teachers. Papers on the teaching of citizenship are grouped together, as are also those on abnormal and backward children. The question of classical education has, of course, a heading to itself. Papers coming under the general head of education occupy nine columns of the Index, but these are subdivided under various subheadings which make reference easy. There are also headings for science study and for technical education.

Thysanoures, Dermaptères et Orthoptères de France et de la faune européenne. Par Prof. C. Houlbert. (Encyclopédie scientifique: Bibliothèque de Zoologie.) Tome I Pp. xii + 382. (Paris: Gaston Doin, 1924.) 16 francs.

THIS clearly written and well-arranged little volume forms a handy and up-to-date work of reference to the orders of insects concerned. The longest section (Part I.) is devoted to the Apterygota or, as Prof. Houlbert prefers to term them, the Thysanura. These he divides into the two sub-orders Collembola and Monomorpha (Thysanura of most authorities) It is prefaced by a general account of their structure (based largely upon the work of Willem), and there follows an exceedingly useful series of family and generic keys, along with descriptions of the various species This section of the volume should appeal to many entomologists since it provides a readily accessible guide to the insects of those two orders The work of Lubbock has long been out-of-date, and the student has hitherto had to rely upon various scattered memoirs (some not easily procurable) for the identification of his material. Part II. deals in a similar manner with the Dermaptera, and Part III is devoted to the general structure and habits of the Orthoptera, descriptions of the species of the latter order being reserved for a second volume The book is fully illustrated and has ample bibliographical references A D I

A Comprehensive Treatise on Inorganic and Theoretical Chemistry By Dr. J. W. Mellor. Vol. 5: *B, Al, Ga, In, Tl, Sc, Ce, and Rare Earth Metals, C*, (Part 1). Pp. x + 1004. (London: Longmans, Green and Co , 1924.) 63*s* net

THE new volume of Dr. Mellor's Treatise includes boron, aluminium, and the rare earth metals, together with a considerable part of the section on carbon. The style and general method of treatment are similar to those used in the earlier volumes and do not call for any comment. Perhaps the most striking feature of this volume is the treatment of the complex compounds of boric acid. Some of these can only be expressed by formulæ such as $KMg_2B_{11}O_{19}$, $9H_2O$, $Mg_7B_{16}O_{30}Cl_2$, or $Cd_5\{H_4[B(W_2O_7)_6]\}_2$, $51H_2O$, and would certainly be omitted from any elementary text-book, but they all find a place in the comprehensive treatise of the author, just as readily as if their compositions could be expressed by formulæ of the simplest kind

The "Chemical Age" Chemical Dictionary: Chemical Terms. Pp. 158. (London · Ernest Benn, Ltd., 1924.) 16*s*. net.

THE dictionary gives the definitions and in many cases short descriptions of a large number of terms used in chemistry. Practically all branches are covered, and the book is up-to-date. A few sections, taken at random, were: deanimation, hæmacytometer, isomerism, oligodynamic action, quinocarbonium, thermodynamics, ultramicroscope, and X-ray analysis, and in each case a clear and accurate account of the topic was presented. The book should prove useful to technical journalists and for general reference, as well as to chemists

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Resonance Radiation and the Correspondence Principle.

THE experiments of Wood and Ellett[1] on the polarisation of the resonant radiation of mercury suggest that it is necessary to make a rather important modification in the quantum theory. The theory of the phenomenon has been examined by several writers,[2] among whom Eldridge has most explicitly directed attention to a case of difficulty. He shows that the observations in a magnetic field are a natural consequence of regarding magnetism as equivalent to rotation, provided that the effect without field is given, but that this effect without field conforms rather to the classical than to the quantum theory.

This is the difficulty. Suppose light of wave-length 2537 Å.U. going northwards and polarised with electric vector in a vertical plane—the points of the compass are merely used to describe relative directions. If this light falls on mercury vapour, an observer to the east sees the resonant light almost completely polarised in a vertical plane, and one above sees practically no light at all. The wave is that which, on the classical theory, would be emitted by an electron vibrating in a vertical line; it may conveniently be called a *linear* wave, and similarly the wave emitted by an electron revolving in a circle may be called a *circular* wave. According to the quantum theory, the resonant line of mercury is associated with a change of angular momentum, and so each atom should emit a circular wave. There is little known in the quantum theory about the process of excitation, but as the electric force is vertical it is natural to suppose that it would give the atom angular momentum about some horizontal axis. However that may be, the radiations from the separate atoms are not coherent, and no possible combination of incoherent circular waves can give rise to a linear wave.

Some sort of explanation could perhaps be constructed by supposing that the electric force in the incident light itself orientated the atoms, and that the resonant radiation was controlled by a Stark effect. This does not really remove the difficulty, for if the vapour were illuminated by circularly polarised light the atoms would have continually to re-orientate themselves, and at such a rate that the concept of the angular momentum of the atom would lose all meaning. The plain fact is that we are dealing with a "degenerate" system, and the degeneracy is of a new kind, exhibiting itself externally and not merely as a purely conceptual question. Any explanation has to face the fact that the atoms are orientated arbitrarily. Since they react to the light in a manner independent of this arbitrary orientation, we must suppose that each single atom is somehow much more isotropic than would be admitted by the ordinary Bohr model. This isotropy might perhaps be attained by supposing the process of excitation to be so slow that the atom passes through all phases of its motion before it is complete.

[1] Wood and Ellett, Proc. Roy. Soc. A, cili. p. 396, 1923.
[2] Breit, *Phil. Mag.*, xlii. p. 832, 1924; Gaviola and Pringsheim, *Ztschr. f. Phys.*, xxv. p. 367, 1924; Eldridge, *Phys. Rev.*, xxiv. p. 234, 1924, and others.

The correspondence principle was formerly enunciated as a rather precise rule by which the results of classical mechanics could be transferred into the quantum theory. There has, however, arisen a tendency to take it in a wider and vaguer sense, as a statement that to any suitable classical theorem there will be an analogue in terms of quanta, and the remaining difficulty is the decision of what theorems are suitable. The present phenomenon strongly suggests a well-known theorem which has not yet been used. A mechanical system vibrating about a state of equilibrium or steady motion usually possesses a unique set of normal modes of vibration, but if some of the frequencies are exactly equal, the modes become ambiguous. Thus a particle vibrating in a plane with equal frequencies for the two directions can describe not only right- and left-handed circles, but also a straight line in any direction. If we apply the correspondence principle to this theorem, it says that if an atom can emit circular waves of equal frequency in either sense, then it can also emit linear waves. We are applying in quite a different branch of the subject Bohr's view of degeneracy, compare it, for example, with his view that in ordinary elliptic motion the eccentricity is not to be quantised, but may have any value.

The accepted form of the quantum theory does not, of course, admit that the same atom can emit both types of circular wave from a given stationary state, but we have seen that it fails to explain the resonance, and the present suggestion is the most natural, if not the only one, which can do so. It must be remembered that there is no direct evidence at all for the emission of purely circular or linear waves from the single atom in the absence of a magnetic field. When there is a field, the degeneracy disappears, the frequencies become unequal, and our theorem is replaced by the straightforward quantum explanation.

There is no avoiding the fact that the theorem has an effect on the quantum theory which is absolutely devastating. Thus there is a failure of all the arguments concerned with the angular momentum of the atom, and therefore of the physical reality of the Bohr orbits. It must, however, be noticed that an idea is entering which is new to the quantum theory, for as the atoms are arbitrarily orientated, the phenomenon requires a definite statement of *phase*. In all previous cases the various linear and circular waves have had unequal frequencies, and so no question of phase arose. There seems to be no reason to give up the concepts connected with angular momentum so long as they are confined to non-degenerate systems or to degenerate systems in which the character of the degeneracy is not studied, and we may expect great further progress by their use. But these concepts are to be regarded, not as ultimate reality, but as a convenient short-cut to the study of complicated systems, and the correspondence principle ought to be applied to the more formal and less physical description of the atom. It is not surprising that the older theory should fail over resonant radiation, for it has shown a complete inability to deal with the other important problem in which phase plays a part, the refraction of light.

It is perhaps possible to argue that a modification might be made in our conceptions of emission without disturbing our ideas of the quantised orbits of the electrons. Even this is not without difficulty, though perhaps it is less insuperable. We have to suppose that the atom is raised to its p-state by the action of the electric force, and that it remains there for a time of the order of 10^{-8} sec. During this time

the precessions and apsidal motions of the electrons will be very large indeed, and it is difficult to see how the atom could, so to speak, remember for so long the axis of the wave it is to emit. Angular momentum would have furnished such a "memory," but the electric force can contribute none about the proper axis.

The discussion is not complete without considering sodium vapour and other substances,[2] but it would take too long to discuss them here. On account of the multiplicity of levels in a magnetic field the effect is more complicated, and the quantum theory is conspicuously successful in explaining the imperfect polarisation, but the difficulty with no field remains outstanding and seems to require the same hypothesis as does the more extreme case of mercury.

May I take this opportunity for a word of personal explanation? At the time that Wood and Ellett were doing their experiments, Prof. Wood very kindly communicated them to me and asked me for an explanation of them. I wrote this back to him in a rough form, making use of a trigger idea for the excitation. I was only regarding this as a quick way of using the classical theory without introducing the fundamental difficulties which lie at the root of it, but I had no opportunity of casting the explanation into a more conventional form in accordance with that theory. I must confess I also had the impression that it would go as well in terms of quanta, but I certainly had no idea either of the special success which would attach to the cases of sodium, etc., or of the difficulty which is the subject of the present letter.

C. G. DARWIN

The University, Edinburgh,
January 2, 1925.

Transmission of Stimuli in Plants.

IN an article in NATURE of October 25 Prof. Dixon [1] has reviewed an investigation of conduction in *Mimosa pudica* which I lately carried out in Trinidad.[2] He agrees with my conclusion that "normal" conduction in the stem has been correctly explained by Dr. Ricca as depending on a stimulant moving with the transpiration current in the wood, but disagrees in that he inclines to consider that Dr. Ricca's explanation is adequate to cover *all* the phenomena of conduction in Mimosa, including conduction in the leaf and the subordinate phenomenon of "high-speed" conduction in the stem. He offers no positive evidence tending to support this view, but criticises the evidence from which I have concluded that Dr. Ricca's explanation will not cover the whole ground.

This autumn, working on *Mimosa Spegazzinii* in Sicily, I have obtained further evidence which confirms my previous conclusion, and provides an answer to several of Prof. Dixon's criticisms, with most of the remainder of which also I am unable to agree. It was found, for example, that in the leaves of cut shoots that had been totally submerged under water for two or three hours, excitation was conducted in both directions considerably *more* rapidly than in similar leaves in air and still attached to the plant. Yet in the stems of such shoots, the velocity of the transpiration current, as measured by ascent of stain, was reduced to about 1 cm. per minute, as against a rate of about 5 cm. per minute in shoots with their leaves in air.

Again, the experiment was repeated of cutting off the tips of leaves under a stain. Previously it was found that in most cases the stain failed to enter the vessels at the leaf tip. The explanation may be that the vessels in some way got blocked, as Prof. Dixon suggests—a possibility that ought certainly to have been taken into account before. But this time the leaves were so manipulated that the stain always entered the vessels. It was, however, sucked back down the leaf at the rate of from 1 to 2·9 cm. per minute only, while in the same leaves at the same time excitation was conducted down at speeds from 6 to 12 cm. per minute.

Similarly, in detached leaves that had stood for some hours with the base of the petiole in water, the rate of ascent of stain was only from 1 to 2 cm. per minute, while at the same time excitation was conducted up them at speeds from 6·2 to 16 cm. per minute. The movements of water in the vessels cannot, therefore, account for excitatory conduction even in the leaf of *M. Spegazzinii*, in which it is much less rapid than in the leaf of *M. pudica*. The results also show that in the leaf the transpiration current ascended much more *slowly* than in the stem, whereas excitation, in *M. pudica* at least, is conducted far more rapidly in leaf than in stem. The details of these experiments it is intended soon to publish.

With regard to Experiment 11, in which all the wood was cut through in the petioles of leaves of *M. pudica*, Prof. Dixon says that it is hard to see why excitation could not have been conducted down by a stimulant passing down the wood and crossing the watery gap. The reason is surely clear. In order to explain basipetal conduction in the leaf by movements of water in the wood, it is necessary to suppose, as Dr. Ricca and Prof. Dixon have supposed, a state of tension in the water columns, which is released by cutting the leaf tip. But in this case, the cut in the petiole had opened up all the vessels to the surrounding water in which the cut was submerged all the time, so that no adequate tension can have existed. It is, therefore, impossible that a stimulant in the water columns should have been sucked back even down to the cut, let alone passing it, as did the excitation, and reaching the main pulvinus, a total distance of about 7 cm., in 3½ seconds. It can only have travelled by the phloem. The conditions were absolutely different from those in the "discontinuity" experiments on the stem, in which a water-tight joint was made between the two portions of stem, in order that the stimulant might be sucked over from one to the other. Moreover, it was pointed out that the next experiment (Expt. 12), which Prof. Dixon does not mention, shows that in preparations consisting of a portion of stem carrying one leaf only, similar to those on which the above experiment also was performed, excitation cannot be conducted basipetally by movements of water in the wood. For the killing of a zone of the petiole by a jet of steam was found absolutely to prevent all basipetal conduction, though acropetally excitation could still be conducted—no doubt by a stimulant moving up in the transpiration current (Expt. 13).

Prof. Dixon does not refer either to the remarkable and more numerous experiments, which I quoted, by Prof. Herbert,[3] who, with a skill much greater than I could provide, had previously interrupted, in various ways, the continuity of the various tissues of the petiole of *M. pudica*, and had concluded that the path of conduction is the phloem. It would be regrettable if proper notice were not to be taken of Prof. Herbert's work, just because he has published in a little-known journal.

Finally, with regard to high-speed conduction in

[2] Ellett, NATURE, December 27, 1924, vol. 114, p. 931.
[1] Dixon, H. H., NATURE, vol. 136, p. 626, October 25, 1924.
[2] Snow, R., Proc. R.S., B, vol. 96, p. 349, 1924.
[3] Herbert, D. A., *The Philippine Agriculturist*, vol. 11, No. 5, 1922.

the stem, Prof. Dixon seeks to explain this as due to a "rupture of the tensile sap" in one or two vessels. In cases in which the cut that set up "high-speed" conduction was found to have reached to the cambium only, and not to the wood, he supposes that the sap in the vessels was ruptured by pressure from the razor upon adjacent cells. He quotes in support certain observations by Böde. Since the cuts were made obliquely and slowly with a sharp razor, there can only have been very slight pressure on the vessels. Further, on looking up Böde's work[4] (p. 101 *seq.*), it will be seen that he does indeed state that pressure from the flat side of a lancet-needle caused bubbles to appear in uninjured vessels of various plants, though strong pressure was needed except in wilting shoots. But he goes on expressly to point out (p. 103) that yet the columns of sap did *not* break. A film of water surrounded the bubbles, which were seen gradually to disappear.

Moreover, my experiments were made on cut shoots, cut under water and rested with their bases in water for at least 1½ hours. No doubt in the upper parts of these shoots there was considerable tension on the water columns owing to the resistance of the conducting channels below. But I find in my notes five cases in which the cuts that set up "high-speed" conduction were made in the basal internodal portion, less than 4 cm. long, below the lowest leaf, including one in which the cut was only 5 mm. from the extreme base, and another in which the cut reached only down to the cambium. In these basal stem portions it is hard to see how there can have been much tension on the water columns. In still another case (Expt. 7) "high-speed" conduction was set up by cutting off a short length from the base of a shoot totally submerged for 3 hours under water. It does not seem possible, therefore, to explain the "high-speed" conduction of the stem either by movements of water in the vessels.

In his letter of January 10, Sir J. C. Bose gives the impression that I have disagreed entirely with his views on conduction in Mimosa. Actually, however, in agreement with him I have produced evidence to show that in the leaf, excitation is conducted in the phloem and has nothing to do with the transpiration current. I agree also that this conduction in the leaf is, in all probability, a true physiological process, and consider that Sir J. C. Bose's experiments on the petiole, which so strongly support this view, are of very great value. In the stem, however, as I found, this conduction in the phloem either fails completely, or at least is regularly too weak to cause the leaves to fall. The result is that in the stem, Dr. Ricca's slower mechanism of conduction by the transpiration current is able to reveal itself. With regard to the "discontinuity" experiment on the stem, it is difficult to take seriously Sir J. C. Bose's suggestion that Dr. Ricca and I both committed the truly remarkable blunder of being misled by a direct effect of the stimulating flame upon the leaves above the water-filled tube. It is impossible that such an accident should have caused a perfectly normal conduction up the shoot, in which the next leaf above the tube did not fall until about 40 seconds after the leaf below the tube. I would refer him to Dr. Ricca's original experiments also, who kept his shoots horizontal. If Sir J. C. Bose has failed to repeat this experiment on the stem, this can only be because his experimental arrangement is unsatisfactory.

R. SNOW.

Magdalen College, Oxford.

[4] Böde, H. R., *Jahrb. f. wiss. Bot.*, vol. 62, 1923.

The Velocity of Oxidation of the Metals and the Structure of Coloured Oxide Films.

WHILE general opinion ascribes the appearance of temper colours to interference between the light reflected from the outer and inner surfaces of a coherent film of oxide, no very definite proof has hitherto been brought forward that this view is correct, and many opinions have been stated to the contrary. The observation of Mallock (Proc. Roy. Soc. 94A (1918), 566) that the colours are unaltered in hue and only diminished in intensity by grinding away the film, has appeared to many to be irreconcilable with the hypothesis that interference is the cause.

We have recently obtained evidence which we believe to render indisputable the claim for interference. In a series of papers published recently in the *Zeitschrift fur Anorganische Chemie*, Tammann has described experiments in which he made use of the film colours (assuming interference as their cause) to measure the rates of "dry" oxidation of the metals. For many of the metals he found the velocity of oxidation to be proportional to t^{-1} (t being the time reckoned from the moment of first exposure to oxygen), the proportionality factor being dependent on the nature of the metal, its temperature, and on the partial pressure of the oxygen. In the course of a study of the oxidation of zinc, in which the rate of fixation of the oxygen was determined directly, it has been found in this laboratory that the rate of reaction is proportional to $t^{-(1-a)}$, where a is small as compared with unity. While these measurements are not therefore in complete agreement with those of Tammann, the close approximation of the two expressions would appear to constitute a quantitative proof that interference is the true explanation of the colours.

Ill-defined colour changes were occasionally noticed in the experiments on zinc described, but since it was necessary to sublime the metal *in vacuo* (to free it from occluded gases), no estimate could be made of its surface area. C. N. Hinshelwood, however, (Proc. Roy. Soc. 102A (1922), 318) gives data for the oxidation of copper from which it is possible to make a comparison of the amounts of fixed oxygen (which he determined directly) with the thicknesses of the films as estimated from their colours. Assuming the oxide formed to be cupric oxide, Hinshelwood gives the following data:

Gm. of CuO per sq. cm. of Copper Foil	Colour of Film
0·000030	Purple
0·000043	Blue
0·000073	Light Green

If, as the interference theory would require, the oxide forms a coherent film which clings tightly to the metal, Tammann is almost certainly correct in supposing that the oxide primarily formed on copper is cuprous and not cupric oxide. For while in the space-lattice of the lower oxide the copper atoms are arranged precisely as in the metal itself, and at nearly the same distance apart (so that the passage from the metal to this oxide can take place with a minimum of disturbance) the higher oxide has a much more complex structure which could only be formed by the breaking up of the original lattice-pattern. Taking the density of cuprous oxide to be (roughly) 6 gm./c.c. and its refractive index as 2·7, the thicknesses of the air-films which should give colours corresponding to those shown by cuprous oxide films containing the above amounts of oxygen per sq. cm.

are calculated to be, respectively, 243, 348, and 590$\mu\mu$. Referring, for example, to the Landolt-Bornstein "Tabellen" for the colours characteristic of air-films of about these thicknesses, one finds the following

257$\mu\mu$ Purpur { 300$\mu\mu$ Himmelblau / 352 Heller Himmelblau } 600$\mu\mu$ Meergrün

If interference were not the cause of the phenomenon, it would be a sufficiently curious coincidence that the thicknesses calculated should come *at all* within the range of those giving rise to Newton's colours.

Hinshelwood remarks that successive oxidations and reductions of a copper surface led to an intensification of the film colours produced, and to a correspondingly greater rate of fixation of the oxygen. He showed that the amounts of oxygen required to form films of the above colours remained in constant ratio. The simplest explanation of these facts would appear to be that the treatment causes a roughening of the surface, whereby the effective area of the metal is increased. If this should prove to be the case, it would provide a not unlikely explanation as to why the colour remains unaltered when the outermost surface is ground away.

D. H. Bangham.
J. Stafford.

Chemistry Department,
Manchester University,
December 12.

Stonehenge: The supposed Blue Stone Trilithon.

I have read with much interest the review which appeared in the issue of Nature for November 1, headed "Archæology of Stonehenge," not only as a thoughtful criticism on my recently published work, but also as a valuable up-to-date addition to the literature on the subject.

The matter of the supposed Blue Stone Trilithon is of some importance in regard to the design of Stonehenge. It has been commonly supposed that the two cup-shaped hollows now to be seen in Stone No. 150 may be mortise sockets, indicating that the stone had been the lintel of a miniature trilithon. In my book I have discussed the subject in some detail, and have given references to authorities and a photograph of the stone. The conclusion arrived at is that these cup-shaped hollows have nothing to do with the original design of Stonehenge, but may very likely have been mortars for grinding grain, formed, perhaps, by prehistoric squatters on the site long after the building of Stonehenge, when the structure was already in a partly ruinous condition.

In reference to this the writer of the review remarks.

> "The author is in error over a fallen foreign stone which figures in Plate 6, Fig. 2, in supposing the two holes seen on it were made, after it had fallen, . It is curved in the same way as are those of the outer circle, but in this one the curve is sharper, showing it belonged to something smaller. The holes in the stone are equidistant from the ends and are dowel holes like those in the big lintels, and this stone may formerly have fitted over the terminal upright stones of the horseshoe."

As a matter of fact, the centres of the hollows in the stone are *not* "equidistant from the ends." The one towards the north is 2 ft. 6 in. from that end of the stone and the other is 1 ft. 11 in. from the farther end. The distance centre to centre of the hollows is only 3 ft. 5 in., and if a drawing be made to scale showing two of the obelisk-shaped stones of the horseshoe at this distance apart (centres), with this supposed lintel on top, it will be seen that the two uprights would have to be not much more than a foot apart in the clear (instead of the normal clearance of four or five feet). The tail-end of the (supposed) lintel would moreover have a considerable unsymmetrical overhang beyond its upright. Such an abnormal arrangement is of course possible, but from what we know of the work of the builders of Stonehenge it may be regarded as most improbable.

An attempt to form a trilithon with this stone as lintel supported on two of the shapeless boulders of the blue stone circle would be found even more impracticable.

It is to be noted, moreover, that the face in which the hollows appear is not even, and the hollows are askew with each other (see Fig. 1). The stone has a considerable curvature which would unfit it for a place at the end of one of the straight limbs of the horseshoe. This curvature is double (slightly S-shaped), and is merely the form of the original boulder. It is not dressed, and has therefore no significance.

It will further be observed that among the blue stones remaining on the site there is no stone that has any sign of a tenon on its top, or which bears any indication that it may have been an upright for a trilithon—nor is there any other stone which has cup-shaped hollows like those on Stone No. 150. All the blue stones (now remaining) are, moreover, exceedingly hard (diabase and rhyolite) and show no sign of weathering.

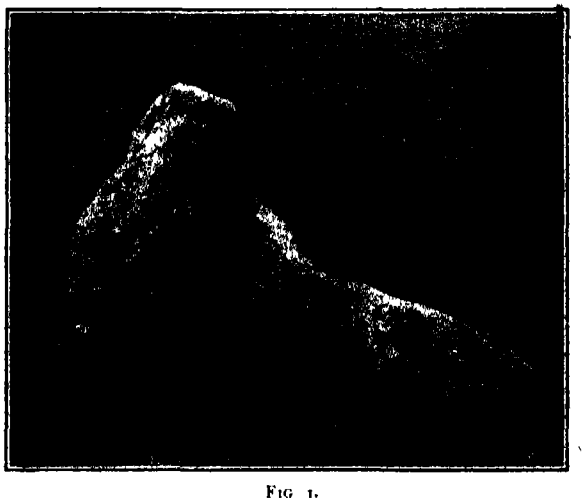


Fig. 1.

On the evidence of the physical facts noted above, and from other considerations set forth in my work on Stonehenge, it may be regarded as extremely improbable that Stone No. 150 could have been the lintel of a trilithon. It will, moreover, doubtless be agreed that if this stone had been dug up in the course of excavation on the site of a prehistoric village, the conclusion that the hollows were mortars for grinding grain would have been accepted as obvious.

Mr. Edward T. Stevens, the eminent Wiltshire archæologist, writing on this subject in 1876, remarks as follows:

> "The two cavities in the prostrate foreign stone are too far from the ends of this particular stone, and too close together, to justify one comparing it with the imposts of the outer circle or outer horseshoe. No trace remains of either of the syenitic uprights upon which it rested. This stone, however, is quite as likely to have served for an altar as for an impost, and the cavities may have been intended to receive libations or offerings of some kind."

Stevens then goes on to describe similar stones found in Sweden known as "elf-stones," which are still held in superstitious veneration and receive offerings to ward off sickness. He adds: "I venture to suggest, therefore, that some further attention be given to this subject, before we jump to the conclusion that this foreign block of stone was an impost" (Jottings on the Stonehenge Excursion, August 1876, pp. 133-138.)

E. HERBERT STONE

The Retreat, Devizes

The Word "Scientist" or its Substitute.

WHEN literary gents, like Sir Clifford Allbutt, Prof. D'Arcy Thompson and Sir Israel Gollancz, come forward in defence of *scientist* and Sir R. A. S. Paget, an expert in vocal sounds, in the most cold-blooded manner possible, says that he would *ist* everybody, it were time that we illiterate sciencers ranged ourselves solidly with Sir Ray Lankester, ever a defender of the faith, proclaiming that we will not have truck with the would-be debasers of lingual beauty.

If I had ever favoured the term—I hate it—I should cease from using it, if only after listening to the High Commissioner for Australia, at the Imperial College of Science (not yet Scientists) dinner, a few days ago. Replying for the guests, at the close of his speech, he referred to the story of two men talking together and one saying—"There will be nothing to laugh at fifty years hence." "What, will there be no scientists!" came the reply. Let us hope there will not be any. The story is a good exemplification of our form in the public eye.

The real men, those who do things—bakers, butchers, builders, boxers, grocers, even green-grocers—all have names ending in *er*. The terminal *ist* is reserved for theosophists, thaumaturgists, even for those who pretend to be but are not chemists, only bits of the same. So far, indeed, is objection taken to chemist that a wag among them has proposed to substitute *chemor*, not chemor-ist, be it noted. The German *chemiker* was long known as superior to the English *chemist*. Still, *er* has its weak side to some—I am told that, in New York, the undertaker seeks to be known as the mortician. The fact is, none of us likes his name.

The Oxford Dictionary, a mine of inspiration which is too little used, gives *Sciencer* and *Sciential*, both euphonious words. Of late, I have often used sciencer, and like it. Sciential has the authority of Keats and is less committal—it may even be applied not merely to the properly scientific but also to those who neither do nor make anything but merely talk and claim to be of the elect, though I should bar classical telepathists. As to Dr. Jeans, for whom solicitude is properly expressed, he may well be spoken of as a sciencer, if not reckoned with magicians all will devoutly pray that he be kept away especially from *ists* in the guise of psychists.

I write this without consulting my sons but believe they would all support me, though I have not gifted any one of them with a musical ear—one of them, however, was brought up under Sir Clifford Allbutt in days when he was the boldest of warriors in defence of our English tongue.

We shall do well to take notice that scientist is fast becoming a word of evil import in the public ear—as meaning one of the set of peculiar people who talk a language no fellow can understand. Some day, soon, perhaps, the call may come to label NATURE: the Journal of Babel; the Dictionary will then give—Babel, the language of a sect devoted to an obscure practice known as science.

HENRY E. ARMSTRONG

SCIENTISTS have hesitated to use the word "scientist," not because it is a hybrid (they are well used to hybrids), nor because it ends in a sibilant "-ist" (they are most of them "-ists," of one kind or another); nor because the word is appropriated by the unqualified (professors are inured to such treatment), nor yet because the word was originally used opprobriously (they are not really less courageous than Tories or Radicals), but because they were diffident. They feared to offend classical taste. No scientist ever puts his pen to paper without casting a fearful glance over his shoulder to see whether a classic should be looking on. You may reproach a classic with ignorance of science and he will plume himself with the compliment. But to suggest to a scientist that he is guilty of a classical lapse is more mortifying to him than to tell him he should have said "napkin" instead of "serviette." It is thus sheer nervousness which has prevented him from using a generic term as obvious and inevitable as is the word "artist." Now, thanks to you, the scientist is discovering, with something of the naiveté of M. Jourdain, that the classic never dreamt of objecting to the word and only wonders why there should be so much shyness about the use of it.

J. W. WILLIAMSON.

Gray's Inn, W.C. 1.

Anomalous Dispersion in the Field of X-Rays.

IN the course of an investigation with the purpose of getting more exact determinations of the wave-lengths of the X-ray spectra, we have carried out a comparison of the lattice-constants of the two crystals, calcite and gypsum. In order to find the best possible value of this fundamental relation, we used a series of different spectral-lines with wave-lengths varying from 0·7 up to 5·2 Å.U. The measurements of the relation are given graphically in Fig. 1, where the values of $\frac{d_1}{d_2} - \frac{\sin\phi_2}{\sin\phi_1}$ are plotted against the wave-lengths. As seen from the graph there are two

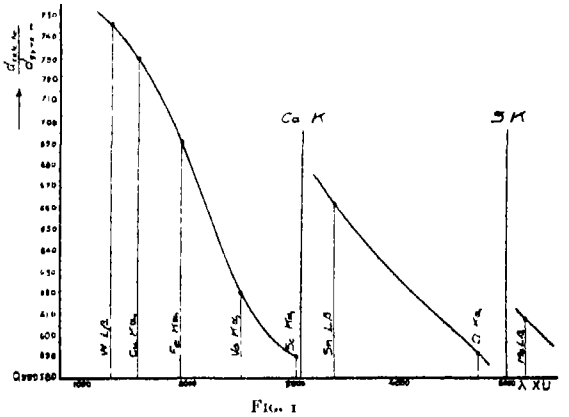


FIG. 1.

marked discontinuities in the run of the curve. It is also seen that these two abrupt variations coincide with the wave-lengths of the absorption-edges of calcium and sulphur.

It may be seen from the theory of X-ray reflection by crystals as given by Darwin and Ewald, that such an anomalous dispersion is to be expected. From these theories it is known that the simple Bragg law of reflection

$$n\lambda = 2d \sin\phi$$

is still valid if we give a modified meaning to the

constant d, that is, if d means, not the true distance d_0 between the reflecting planes but a corrected value

$$d = d_0\left[1 - \frac{4d_0^2}{n^2}\frac{\delta}{\lambda^2}\right],$$

where δ has the value known from the ordinary dispersion-theory.

$$\delta = \frac{e^2}{2\pi c^2 m}\sum_{s=K,L,M}{}' \frac{N_s}{\nu^2 - \nu_s^2},$$

and ν_s are the natural frequencies of the K, L, M, etc electrons

On passing one of the natural frequencies, the value of d apparently undergoes an abrupt variation quite in accordance with the experimental results

It may be noticed that the graph is not a simple dispersion-curve, as it gives the relation between *two* such curves, namely, that of gypsum to that of calcite. The discontinuity at calcium is due to the fact that the relative number of the K-electrons of this element per unit volume is different at the two crystals

This result shows that it is necessary in all accurate measurements of X-ray wave-lengths to use a corrected Bragg formula for the calculation of the wave-lengths from the angles of reflections For this purpose, the first condition is to know the dispersion formula of the crystal for X-rays Such an investigation may be carried out with the ordinary prism-method applied for X-rays, as shown in a communication from this laboratory (*Die Naturwissenschaften*, December 26) or with the method given by Bergen Davis and his collaborators

ELIS HJALMAR.
MANNE SIEGBAHN

Fysiska Institutionen,
Upsala Universitet,
December 12

Scattering and Absorption of γ-Rays.

IN a recent letter to NATURE (January 3, p. 13) I have stated that, on current theories, it is exceedingly difficult to account for the results of experiments on the scattering and absorption of hard γ-rays. I should like to add to this statement that a reasonable explanation of such results has since been obtained by means of the following assumptions, for which there is a certain amount of evidence

1 The secondary β-rays produced in light elements by hard γ-rays are practically all recoil electrons.

2 The photoelectric or fluorescent absorption coefficient of γ-rays varies as the cube of the wave-length

3. The hard γ-rays of radium-C behave in the same manner as would a mixture of two types of wave-lengths 0 024 and 0 008 Å U. respectively, each type having about 50 per cent of the total energy

4 The number of quanta scattered per unit area at an angle θ varies as $(1+\cos^2\theta)/(1+2\alpha)$, where $\alpha = h\nu_0/mc^2 = 0\ 0242/\lambda_0$, h being Planck's constant, ν_0 the initial frequency, m the mass of an electron, c the velocity of light, and λ_0 the initial wave-length.

With the angular distribution of "scattered" quanta proposed above, the average energy of a recoil electron, for values of $\alpha > 1$, approaches closely the maximum energy E_M which equals $2\alpha h\nu_0/(1+2\alpha)$ Further, as α increases, the total energy of the recoil electrons becomes a greater and greater proportion of the energy lost by the scattering process, *e.g.* when $\alpha = 3$, the total energy of the recoil electrons is equal to twice the energy of the scattered γ-radiation. These are the reasons why one can account for the observed energy of the secondary β-rays when it is assumed that a large proportion of the total γ-ray energy is of the softer type, it being necessary to assume that this type is present in order to account for the observed values of the fluorescent absorption coefficient

It might be mentioned that, with distributions of scattered quanta hitherto proposed, the average energy of a recoil electron is about $\frac{1}{2}E_M$, and the total energy of the recoil electron is always less than that of the scattered γ-radiation.

I believe it can be shown, from what has been proposed above, that γ-rays must have a "range"; *i.e.* for rays of any one wave-length, there could be a certain thickness of material, through which the rays would not pass, no matter how great the initial intensity. This would indicate that the scattering of γ-rays is a scattering of "corpuscles," a view which I referred to and rejected in a former paper (*Phil. Mag.*, p 611, 1913)

In my letter of January 3, p. 13, it is stated that, "Taking the average energy of such a β-ray to correspond to 467,000 volts, . . a simple calculation shows that only one in every five radium-D atoms emits a γ-ray on disintegration" The figures should have been 333,000 volts and only one in every seven radium-D atoms emits a γ-ray on disintegration

J A. GRAY.

Queen's University,
Kingston, Ontario

Spermatogenesis of *Succinea ovalis*, Say.

AN investigation of the spermatogenesis of *Succinea ovalis*, Say., a small terrestrial pulmonate of North America, has revealed the following

1 Forty chromosomes are found in the spermatogonial divisions, and twenty in the maturation divisions

2 Typically of all pulmonates so far studied, there are two centrioles, proximal and distal. Early in spermogenesis the proximal centriole penetrates through the nucleus of the spermatid, and with the surrounding intranuclear canal, forms an intranuclear rod in very much the same way as has been reported for certain prosobranchs

3. Both the head and tail of the spermatozoon have a spiral twist. These spirals go in either a clock-wise or counter clock-wise direction, one type being about as common as the other.

Of the cytoplasmic structures, the mitochondria and the Golgi apparatus were followed through all stages of spermatogenesis

The mitochondria are seen in the early primary spermatogonia as small masses of granules lying near the nuclei. They increase in size and number in the primary spermatocytes, and at each of the maturation divisions they are distributed approximately equally between the daughter cells. Some of the granules go to form the sheath of the axial filament of the spermatozoon, while the rest are sloughed off with the cytoplasmic balls.

The Golgi rods cannot be identified with certainty in the primary spermatogonia. In the primary spermatocytes they occur as conspicuous banana-shaped rods grouped closely around the idiosome; 15-20 rods can be counted in these stages. During dictyokinesis there is no fragmentation of individual rods, but they are distributed intact to the daughter cells 3-5 rods are found in the spermatids. In the final ripening of the spermatozoon, the apparatus is seen in the cytoplasmic balls as faintly-staining, disintegrating bodies.

A more detailed account will be published later.

CLEVELAND P. HICKMAN.

Department of Biology,
Princeton University, U.S.A.,
November 26.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

3 BALFOUR STEWART (1828–1887)

IF I were asked to name Balfour Stewart's outstanding quality as a scientific investigator, I should designate his absolute freedom from preconceived ideas both in the selection of his subjects and the manner in which he treated them. He was fond of arguing by analogy or familiar illustration. According to the writer of his obituary notice in the Proceedings of the Royal Society, who knew him intimately, he was "full of the most weird and grotesque ideas." I cannot say that I ever became conscious of this in my own intercourse with him, but I only came into contact with him after his slow recovery from the injuries sustained in the Harrow railway accident of 1870. He was not a good lecturer and had difficulty in keeping order in the lecture-room—perhaps it would be more correct to say that he did not take the trouble to keep order, being too sympathetic with youthful exuberance. In the laboratory he was an inspiring teacher, and it would not be an exaggeration to say that he was the godfather of much of our modern science, both Poynting and J. J. Thomson having received their first lessons in physics from him.

Balfour Stewart's family intended him for a mercantile profession, and at the conclusion of his university studies he spent some time in Australia. But science had laid its spell on him, and he soon returned to Edinburgh, where he became assistant to J. D. Forbes, who had considerable influence in shaping his mental outlook. It was during the six years he spent at Edinburgh that the work on the equilibrium of temperature radiation was begun and, in its essential features, completed. In 1859, Balfour Stewart was appointed superintendent of the Kew Observatory, which was then managed by a committee of the British Association under the presidency of P. Gassiot. All went well until the organisation of the meteorological service of the country was transferred from the Board of Trade to a committee of the Royal Society, consisting of eight Fellows, with General Sabine as chairman. The expenses were covered by a Treasury grant of 10,000*l.*

Trouble soon arose, and, I think, both for their historical interest and in justice to Balfour Stewart's memory, an account of the incidents which ultimately led to his retirement from the directorship of Kew Observatory should be given. I am enabled to do so on the evidence of the relevant documents, which came into my keeping after Balfour Stewart's death. When the Board of Trade had agreed to the request of the Meteorological Committee for the assistance of a scientific secretary, Balfour Stewart was appointed to that office, understanding that he was to be the scientific adviser of the Committee; but when afterwards he was designated simply as "Secretary to the Committee" he disliked the omission of the qualifying word "scientific," but acquiesced. "Nevertheless," he declared in a printed statement from which I quote, "I continued to understand that it was my special duty, in case I might see anything defective in the scientific position of the Committee, to urge them to amend it."

[1] Continued from p. 57.

Differences of opinion soon arose between Sabine and Stewart with regard to the method of reducing meteorological observations, and his repeated requests for clerical assistance were declined by the Committee. The crisis came when Balfour Stewart directed General Sabine's attention to what he considered to be an error in an unconfirmed minute of one of the meetings of the Meteorological Committee. Stewart's account of the interview which took place concludes with the following statement: "He [General Sabine] assured me there was no mistake and added in answer to a question that he, *on his own responsibility*, had authorised the preparation of such of those results at the central office as had not been authorised by the Committee." To use a familiar term, Sabine admitted having cooked the minutes. At the same time, Balfour Stewart was privately told that the chairman was much opposed to his scheme of reducing observations, and that there was not much chance of its being adopted. With regard to the merits of the proposed scheme there can be little doubt. Stewart had submitted it to a few independent men of science and the reply of the Astronomer-Royal, Sir George Airy, may be given *in extenso*:

> "I have read with much satisfaction the paper of your Remarks on Meteorological Reductions, etc., especially with reference to Vapour. I do hope that by going on thus you may make Meteorology a science of causation, and raise it from its present contemptible state.
>
> "I have often thought that much may be gained by ascertaining at what rate aqueous vapour disseminates itself through air, and should long ago have made experiments, but that I want a hygrometer of sufficient delicacy. I then thought of suggesting it to the Kew Committee. Your paper restores the interest in my old intention, and I think I shall write to Mr Gassiot."

Lord Kelvin (then Sir William Thomson) also gave his full approval, writing:

> "I believe the plan you propose is adapted to bring out information of the most valuable kind, from observations which, until reduced on some such plan, might be accumulated indefinitely without any practical benefit."

Stewart was naturally distressed by the manner in which his advice was set aside, no scientific grounds being given. Fearing that the anxieties of his office might affect his health, he wrote a letter to the chairman of the Committee resigning the secretaryship. He also tendered to Mr. Gassiot his resignation as superintendent of Kew on the ground that the two bodies were closely bound together, but declared at a meeting of the Meteorological Committee that he gave up this office with extreme reluctance. He was asked, in an interview with Mr. Gassiot, whether there was anything that would induce him to withdraw his resignation, and was given to understand that Sabine would wait to hear the condition under which he would continue office before taking further steps. Stewart then wrote a letter explaining the difficulties

in which he was placed owing to insufficient help in the numerical work and stating that, if some assistance were given him in the preparation of the preliminary reductions of the observations, he desired to withdraw his letters of resignation. The reply was as follows:

"I regret that you were so determined to send in your resignation It appears Sir Edward Sabine has written to Bombay, where Colonel Smythe is, and nothing can be done until the reply comes."

Sabine's letter referred to, offering the appointment to another man, was posted on the day of the interview with Gassiot, and as Stewart points out—before his resignation had been formally accepted by the respective committees

The obstinacy with which Sabine pressed his own opinion is perhaps intelligible in a man who was then eighty-one years old, but there is nothing to say in extenuation of the want of generosity exhibited in the following letter to Stewart:

"My not having responded to your request more promptly and more fully, has not arisen from want of solicitous thought, and wish to serve you.

"I feel assured that if your work at Kew had ere now been crowned by the looked-for completion of the account of the results of the long and invaluable series of magnetic observations, the later and longer portion of which were under your own superintendence, you might, and I might, have appealed triumphantly to such an evidence, not only of what you were capable of doing, but of what you had done, as placing you in a pre-eminent position"

The letter is dated May 31, 1870, and was presumably written in answer to a request for a testimonial in view of Stewart's candidature for the chair of physics at Owens College, Manchester With regard to the implied complaint, I have before me the copy of a letter written by Balfour Stewart, from which it appears that he was waiting, previous to 1865, for the details of the observations which were in Sabine's possession In spite of his repeated requests they were never sent to him. He could scarcely be expected to start on an extensive work of reductions before he had the whole material before him.

Balfour Stewart's greatest scientific success was achieved in his researches on the equilibrium of radiation in an enclosure of uniform temperature, which led to the enunciation of the connexion between radiation and absorption. His omission to drive home convincingly the application of his results to the explanation of the dark Fraunhofer lines was, in his own later opinion, due to a want of chemical knowledge Looking at a flame coloured with common salt, and believing that the yellow colour of the flame was due to luminous sodium chloride, he was disappointed to find that a plate of rock salt did not sensibly absorb the emitted light

Stewart had the faculty of recognising the importance of problems, even when he had not the power theoretically or experimentally to make much headway in their solution. He saw, for example, the need of studying the temperature equilibrium in an enclosure which contained moving bodies, both radiation and absorption being affected by the Doppler effect. But instead of looking for the solution of the difficulty—as was subsequently done by Wien—in an adjustment of the law of radiation as depending on temperature and wave-lengths, he imagined that the equilibrium of radiation was actually destroyed, the second law of thermodynamics being satisfied by the mechanical forces necessary to maintain the motion. In conjunction with Tait he designed an experiment in which a disc was kept rotating *in vacuo*, and believed he had actually discovered an increase of the temperature of the disc The success of the experiment depended of course on the perfection of his vacuum, and Stewart shared the erroneous belief of the time that a perfect so-called chemical vacuum could be obtained by filling a vessel with carbonic acid, exhausting with an ordinary air pump and absorbing the remnant of the gas with caustic potash.

I have remarked that Stewart's mind worked a good deal by analogies He was fond of one particular illustration Imagining a moving train and a body of men cutting across by jumping into it from one side and out of it at the other, it is clear that the train will gradually lose speed The idea was applied to special cases and suggested several experiments to him. I joined him in one of these, in which an electric current was passed through water and an electromotive force applied at right angles to the current Stewart hoped to detect some interference of the currents with each other The same type of reasoning was in his mind in contemplating possible mechanical effects of radiation I believe that at the bottom of these speculations was some prophetic glimmering that a propagation of energy always implies a propagation of momentum. The weak feature of his work was, that he often designed and tried experiments of a refined nature with appliances which were insufficient, and even at that time might have been improved upon—such were his attempts to discover a screening effect of metals on gravitation, or a change of mass by chemical combination In the latter experiments, in which the combining bodies were mercury and iodine sealed up in a glass bottle, J J. Thomson, who assisted him, nearly lost his eyesight through an explosion.

Stewart was indefatigable in his work While the days were spent in the laboratory, he pursued his statistical investigations on magnetic and solar phenomena in the evenings. Some of these researches are published under the joint names of himself, De la Rue and Loewy. The latter gentleman—though I believe he had some claim to scientific knowledge—was chiefly employed as an assistant, paid for carrying on the numerical work, which was often heavy. I believe that De la Rue's share consisted in supplying the funds. One morning Stewart arrived at the laboratory in a great state of distress. In looking over the proofs of a paper accepted for the Philosophical Transactions, he had found that the numerical work was all wrong. Loewy had, in fact, saved himself trouble, and evolved the results out of his inner consciousness. The paper had to be withdrawn, and De la Rue paid a substantial sum for the expenses already incurred in printing. Neumayer, who was at the time director of the "Sternwarte" at Hamburg and on whose recommendation Loewy had been engaged, told me afterwards that he had sent for Loewy and charged him with manipulating the results. Loewy admitted doing

this, but excused himself on the ground that, while he had originally worked honestly, Stewart had never checked his results, so that the blame must be his

Some reference should be made to a little volume, "The Unseen Universe," published in 1875, and intended to reconcile science with revealed religion It appeared anonymously at first and, though probably forgotten now, it created a sensation at the time, running rapidly through many editions, in the later ones of which the authors' names -- Balfour Stewart and P. G. Tait—were given Referring to Tait's contribution, Stewart told me that when he first approached him, suggesting a joint publication, his consent was subject to the condition that Stewart should write the book while he would make himself responsible for the preface When this was agreed to and the manuscript of the preface arrived, Stewart was amused to find that it was almost entirely taken up with an attack on John Tyndall, who was Tait's *bête noire* It had to be re-written, and to judge from internal evidence I should surmise that not much more than the first paragraph was Tait's work I am under the impression, nevertheless, that Tait's share in the book was not negligible, and that though he acted mainly in an advisory capacity at first, he made substantial additions in the later editions.

Towards the close of his life Stewart became much interested in so-called spiritualistic phenomena, but he always insisted —sometimes with great vigour—on his disbelief in messages from the dead, which were contrary to his religious convictions With regard to unexplained phenomena, in which fraud may possibly have a share, it must be said that Stewart's confiding nature rendered him quite unfit to act as a judge He was like a child in these matters. A certain personage near Buxton —so far as my recollection goes, a clergyman—wrote to Stewart about his powers of second sight, which enabled him to find a hidden object or name a card drawn at random out of a pack. Stewart went to see him several times and was impressed. "What is most remarkable," he told me after the second or third visit, "is that the power can be transferred to others There is a servant girl in the house who, after a stay of a few weeks, has acquired it and can now name an unseen card just as well as her master" Not a shadow of suspicion had crossed his mind

Stewart's conversation was always suggestive and sometimes witty The Principal of Owens College had a habit of writing letters to the professors when he had any fault to find These always began with some complimentary remarks, the sting being reserved for the concluding sentence, or frequently a postscript "Every billet has its bullet" was Stewart's comment after receiving one of these communications.

The Theory of Evolution since Darwin.[1]

By Prof E. W MACBRIDE, F R S

THE most recent development of the doctrine of evolution is the revival of Lamarckism—that is, the belief in the inheritable nature of the effects of use and disuse Just as Bateson in 1894 enunciated the doctrine of the origin of species by sports long before this view was consecrated by the experimental labours of De Vries and given the name of the "mutation theory," so Eimer (1887) and Cope (1888) rebelled against the Weismannian conception of an unalterable germ plasm totally independent of the effects of the experiences of the body Eimer put forward the doctrine of orthogenesis. This theory states that variations are the results of the effects of the environment on the complex constitution of the living organism, but that this constitution determines the character of these variations; they are not indefinite, but take place in a few definite directions. Eimer, who chose for his special subject of observation the wall-lizard *Lacerta muralis*, and later the swallow-tailed butterflies, pointed out that new variations make their first appearance in the later stages of growth and become inherited earlier in life as the generations succeed one another. A beautiful example, he explains, is afforded by the Ammonites, in which new features are first distinguishable in the outer coil of the shell, which is, of course, the youngest and latest to appear, whereas in succeeding strata the new feature is found affecting the more central coils. Thus it will be observed that Eimer draws the most decisive support for his theory from palæontology. Eimer seems to suppose that he is an opponent of Lamarck, but the only difference between them that I can discover is that Eimer seems to regard external conditions as altering the hereditary tendencies by direct action as sulphuric acid acts on metal, whereas Lamarck considers that external conditions stimulate an organism to make a response, and that it is this tendency to response that is inherited

Cope, in his book "The Origin of the Fittest," likewise advocates the inheritance of the effects of use and disuse, and relies on palæontological evidence to support his view He points out that if the development of the Ungulates during the Tertiary period followed, we find evidence that the shocks and strains to which the leg bones were subjected, and which in moderation create enlargement and strengthening of those bones during the lifetime of the individual, gave rise, as generation succeeded to generation, to permanent thickenings, fusions, and elongations of these bones; and that the modifications in teeth can likewise be explained as reactions to the changing character of the food by which the Ungulata were supported Cope's views have become increasingly prevalent amongst North American palæontologists, and are almost universally accepted by them to-day

The first great blow to Weismannism was delivered by the cytologists and experimental embryologists The foundation stone of the "germ-plasm" theory was the fundamental distinction between body cells and germ cells, and the theory that, as development proceeded, the body cells were specialised so that each could only give rise to its special part of the body. But Driesch showed (1900) that if certain segmenting eggs were fragmented, a piece so small as one-eighth of the whole could give rise to a complete embryo, and Hertwig and Driesch further proved that the arrangement of these cells could

[1] Continued from p. 55

be entirely altered by pressure, so that cells which normally gave rise to the front or back were displaced to the sides, and yet that perfectly typical embryos were formed. More exact methods of investigation showed that the structure of all the nuclei in the body was alike, so that each cell might be regarded as a potential germ cell, and that the differentiation of the organs of the body was not accompanied by a differentiation of the nuclei but was due to local changes in the protoplasm. Therefore the same kind of nucleus—if the nucleus was to be regarded as the fount and director of life in the cell—must respond differently to different stimuli in different parts of the body

Previous supporters of Lamarckism had assumed the necessity of the inheritability of the effects of use and disuse in order to account for changes which could be shown to have occurred, but it was not until 1908 that definite experimental evidence was adduced to show that changes artificially induced had, as a matter of fact, been transmitted to posterity If this evidence were accepted, it was clear that the whole status of the questions must undergo a profound change, for a *vera causa* for the production of functional variations—in a word, of adaptations—would have been discovered. We have seen that strong evidence has been brought forward to show that minute differences distinguishing brothers and sisters of the same family were not inheritable, while "mutations" or "sports" were strongly inherited These sports are, however, invariably pathological or monstrous in character, and if they occurred in Nature would have no chance of surviving or propagating their like

The evidence in favour of Lamarckism was based on experiments with salamanders and toads which were carried out in Vienna There exist two kinds of salamander in Europe, and one of them gives rise to only two young which at birth resemble their mother. The gilled fish-like larval stage with which the typical amphibian begins its free existence is in this salamander passed over within the womb of the mother The colour of the skin is black and the animal lives on the cool Alpine uplands—it is named *Salamandra atra*. The other species of salamander is marked with bright yellow spots on a black background; it is an inhabitant of the lowlands and it gives birth to a considerable number (about thirty) of gilled young, which live for six months in the water before the gills drop off and the animals come on land. This species is named *Salamandra maculosa* Now Dr. Kammerer, the investigator who performed these experiments, showed that if *Salamandra atra* was gradually accustomed to living in warmer and moister conditions, as reproductive period succeeded to reproductive period, it produced more young at an increasingly earlier period of development, and that when these young were reared to maturity and allowed to pair, the second generation gave rise to about half-a-dozen gilled young which took to the water and acted like the larvæ of *Salamandra maculosa*. Conversely, if *Salamandra maculosa* were made to live in comparatively cool and dry conditions, it began to carry its young for longer periods in the womb; fewer were produced at a birth, but these were born at a more advanced state of development. Finally, when these were reared to maturity and allowed to pair, the second generation gave rise to only two or three at a birth, and these were provided only with vestigial stumps of gills, so that they at once took up a terrestrial life.

If, again, the young of *Salamandra maculosa* just after metamorphosis were reared in cages the walls of which were painted yellow and black respectively, in those confined in yellow cages the yellow spots extended in area as the animal grew to maturity, so that after four years they were arranged in two conspicuous rows along the back. If two such animals were allowed to mate and produce offspring, when the resulting generation grew to maturity under the same conditions as did their parents, the yellow extended to such an extent as almost to suppress the black pigment. Those salamanders, on the contrary, which were reared in the black cages contracted the area of their yellow spots as they grew up; and when the second generation were reared under similar conditions, the animals became almost, if not quite, as black as *Salamandra atra* The full effect, therefore, required two generations exposed to the same conditions to show itself, and the second generation started, so to speak, where the parents left off. If the offspring of salamanders which had been reared on a yellow background were reared on a black background, the yellow spots increased in area during the first six months of the animal's life; only after this period did the black begin to gain the predominance, in a word, the animal during the first period of its life *recapitulated* the history of the previous generation This experiment constitutes, so far as I can determine, the first experimental proof of the biogenetic law which has ever been made When the offspring of salamanders which had been reared on a black background grew up on a yellow background a unique effect was produced: the animals developed a single median stripe of yellow on the back This is a form which is practically never found in Nature and can only be produced by experiment.

If we now turn to the experiments on toads, we may observe that nearly all toads, like the frogs, pair in water in the spring-time The male embraces the female with his forearms and keeps her firmly in his grasp for a considerable period—often for weeks—until she emits her spawn, which he then fertilises. In order to enable him to retain a firm hold of his partner's slippery body, he has developed under the index finger a horny pad covered with minute asperities, the so-called nuptial pad. Now Alytes differs from all other toads in that pairing takes place on land, and as the female's body is comparatively dry and thorny the male does not require a nuptial pad in order to enable him to retain a hold on her. The eggs are fewer and larger in size than are the eggs of other toads; but as in other species, they are emitted in a string connected together by a cord of jelly. The male winds these cords round his legs and remains encumbered with them until the young tadpoles hatch out, a curious habit which has earned for him the name of "midwife toad." The tadpoles of ordinary toads emerge from the egg provided with three feathery gills on each side; as they grow these gills become covered over with a fold of skin proceeding from the head, and the larvæ assume the familiar form of a rounded body and flattened tail characteristic of

the tadpole. The tadpoles of Alytes, however, pass through the stage with external gills whilst still within the egg-shell and emerge only when the body has become, as in the later toad-tadpole, rounded and plump. Whilst in the egg-shell they have only *one* external gill on each side.

Now Kammerer showed that although Alytes normally lived in cool spots, it could be induced to live at a warm temperature if it were provided with a basin of water in which to lave itself. In these circumstances, however, the male and female paired in water, and the eggs slipped off the legs of the male and lay in the water. By taking special precautions to keep the water aseptic, some of these were hatched and the resulting tadpoles reared to maturity. The next generation reared under similar conditions produced more numerous eggs which were smaller than those of the normal Alytes. Out of these eggs the tadpoles hatched in the external gill stage with one external gill on each side. In the next generation reared under similar conditions the tadpoles were provided with three external gills on each side as in ordinary toads, and in this generation the males developed horny pads.

These experiments aroused a quite different kind of criticism from that which had been evoked by any previous work, and one which strongly recalled the "odium theologicum" with which the first presentation of Darwin's theory of evolution was received in 1859. The experiments were admitted to be conclusive if true, but some critics declined to accept them. Kammerer visited England less than two years ago, bringing with him critical specimens, amongst them salamanders with a median stripe of yellow and a male Alytes showing the horny pad. Even then the critics were not convinced. It was asserted that the pad in the normal frog or toad was on the upper side of the hand and not on the lower side, and that therefore the specimen produced had not a true horny pad. In answer to this Kammerer asserted that in his Alytes—as his critics would have seen if they had examined it carefully—the nuptial pad was developed on the dorsal surface of the fingers but extended also round to their palmar surfaces, and to this answer I can add that the first four male frogs which I examined after this discussion all showed the pad on the lower surface of the hand as well as on the upper. But Kammerer showed other specimens on the same occasion which reduced all the discussion on the subject of the pad of Alytes to the level of "straining at a gnat and swallowing a camel." For all critics and supporters of Lamarckism alike admit that Alytes is descended from ancestors which, like more normal toads, possessed pads, and that the appearance of a pad in Alytes is therefore an atavism.

The most wonderful experiment, however, which Kammerer has ever published was that in which, *in one generation*, he had induced the blind cave-newt Proteus to develop a fully-formed eye. These creatures he brought with him to England, and there was no possibility of mistake about the matter. Proteus cannot be confounded with anything else; its pale flesh colour and reduced limbs are characteristic, and newts of this kind with large well-formed eyes were shown at the discussion. One is inclined to ask whether it is easier to produce a fully-formed eye than a mere cornification of the skin.

Kammerer's results have in the meantime been confirmed by the independent work of Durkhen on the colour of the pupæ of white butterflies. This work was carried out in the University of Breslau, and was published in 1923. The pupæ of this species normally have an opaque skin of a greyish-white colour, but in a small percentage (about 4 per cent.) this colour is absent and the skin is transparent, and so the pupa appears green, owing to the green blood shining through. If, however, the caterpillars are exposed to orange light, the formation of the white pigment of the pupa is largely inhibited, and the proportion of green pupæ rises to 65 per cent. If these pupæ are allowed to develop into adults and produce offspring and the caterpillars of the second generation are exposed to the same conditions, then the proportion of green pupæ rises to 95 per cent.; if the caterpillars of this generation are, however, left in ordinary daylight, the proportion of green pupæ diminishes, but is still 34 per cent. as compared with 4 per cent. in the controls. Here, as in Kammerer's experiments, we see that the reaction to the environment on the part of the first generation affects the second generation, and that a trace of it persists even when the second generation is replaced in the original conditions.

In England, Dr. Heslop Harrison, of the University of Durham, has observed that a certain melanic variety of moth is found where the food plants are infected with manganese salts derived from the smoke of adjacent factories. He fed the pale variety of this moth on food impregnated with the salts of manganese, and after several generations succeeded in obtaining melanic specimens, and from these he obtained a melanic progeny which bred true.

We are, therefore, in a position to state that after the lapse of the first quarter of the twentieth century, the doctrine of Lamarck has been submitted to the crucial test of experiment and proved to be true. Now evidence of the actual course of evolution is derived from three classes of facts, namely, those of systematic zoology (*i.e.* the mutual relations of varieties and species), those derived from a study of embryology, and, finally, those deduced from palæontology or the study of fossils, and systematists, palæontologists, and embryologists alike have been forced to the conclusion that the effects of habits must be inherited in order to account for the facts which they find in Nature. We are therefore justified in saying that habit, which is the reaction of the animal to its environment, has been the great factor in evolution, and that the splitting of the original stock into divergent species has been due to different members of the same stock under the stress of different environments adopting different habits. Prof. McDougall in "Psychology" has shown that this readiness to adopt new habits is a universal characteristic of living beings. "An animal when its activity is roused by a stimulus," writes McDougall, "pursues an end, and its activity continues till that end is attained or until it is exhausted. If it fails to attain that end in one way, *it will endeavour to gain it in another* until it achieves success." In this sentence, we venture to think, is contained the key to the riddle of evolution.

We might leave the subject here, but considering the vogue that the mutation theory of evolution has had, it is proper to consider whether any definite cause for these mutations can be found, and if so, what relation this cause bears to the reactions which set up habits.

Nothing has been more remarkable than the consensus of opinion of the upholders of the mutation theory that mutations are due to "chance," and yet, as Huxley remarked, one had hoped that a belief in chance had been finally exploded Quite recently, however, a physiological cause for mutations has been suggested by Tornier, and much evidence in favour of it has been collected by him. The special subject of his investigations was the goldfish The most bizarre races of this creature have appeared, and these races when crossed produce offspring which obey the Mendelian rules. Now Tornier showed that the races of goldfish had been derived from a small species of carp which inhabits the rivers of China. He found that the Chinese breeders kept their stock in small dark jars under insanitary conditions in which they were scantily supplied with oxygen Much of the spawn died, and among the survivors all sorts of abnormalities turned up; from these the most striking specimens were selected and used to found the new breeds These facts suggested to Tornier the view that the cause of the mutations was the weakening of the developmental energy of the germ by the abstraction of oxygen during an early and critical period of development

Tornier showed that this weakening had two consequences: (1) it made the embryo sluggish in its movements, and (2) it diminished its power of regulation of the various processes on the harmonious co-operation of which the upbuilding of the body depends. Thus enormous fins were produced by the swelling of the yolk in consequence of undue absorption of water underneath the skin-area from which the fin developed, telescopic protruding eyes by the engorgement of the growing eyeball with water, and so on. By treating the eggs of newts and toads in such a way as partly to suffocate them for a short period after fertilisation, similar embryos were produced. Independently of Tornier, Jansen had arrived at a similar explanation of the cause of human deformities, the part played by the pressure of the swollen yolk in the goldfish's egg being assumed in the human embryo by the pressure of a too closely adherent amnion. What is inherited is, according to Tornier, not a factor or gene for an enlarged fin or protruding eye, etc., *but a certain grade of germ-weakness which in each succeeding generation produces the same morphological effects*

If this view is correct—and all the evidence available conspires to show that it is—then mutations can have played no part whatever in evolution Since they are the outward and visible signs of a weakened constitution, they are in a state of Nature ruthlessly weeded out by natural selection. Nevertheless they, like functional adaptations, are the result of the action of the environment—only in their case the animal has *failed to respond* to the changed conditions, whereas evolution depends on cases where the animal *has successfully responded*. In the last resort, therefore, like Darwin we come back to natural selection, only what is "selected" is not a chance variation or peculiarity but the constitutionally vigorous individual with ability of self-adaptation; what is rejected is the individual of weakened constitution.

Obituary.

SIR WILLIAM E. GARSTIN, G.C.M.G., G.B.E.

SIR WILLIAM GARSTIN, whose death at the age of seventy-five occurred on January 8, commenced his career in India in 1872 as an officer of the Public Works Department, after studying engineering at King's College, London Thirteen years later he was invited by Sir Colin Scott Moncrieff, who had just taken charge of the Public Works Ministry in Egypt, to make one of the small group of Indian engineers who were undertaking the reorganisation of the irrigation system of Egypt, which was at that time in complete disorder

In charge of the Circle of Irrigation which included the eastern half of the Nile Delta, Garstin spent seven arduous years in effecting his share of the restoration of the irrigation system, and then, on the retirement of Col Justin Ross in 1892, he was appointed Inspector-General of Irrigation for the whole country. A few months later, on the retirement of Sir Colin Scott Moncrieff, he became Under-Secretary of State in the Ministry of Public Works.

At that time the irrigation system was being rapidly improved; the basin irrigation of Upper Egypt had been largely remodelled by Col. Ross, improvements in the Delta had led to large increases of crops, and larger supplies of water in the early summer were urgently required. Plans for a reservoir in or near the Nile Valley were being studied, and it fell to Sir William Garstin to advise on the scheme to be adopted. As a result, the Aswan Dam with subsidiary barrages at Assiut and Zifta were built, and by these means, and later developments of them, Egypt's low-stage water supply was assured.

As soon as Omdurman had fallen and the Sudan had been retaken, Garstin took prompt measures for the clearing of the Bahr el Jebel and the Bahr el Ghazel from the "sudd"—those blocks of drift and growing vegetation which had closed many of the channels Sir William visited the Sudan on numerous occasions, and especially in 1901, and again in 1903, when he traversed Uganda also to see the headwaters of the Nile system. The investigations and surveys which were then initiated have since furnished a mass of hydrographical information of the highest value both to Egypt and to the Sudan.

Although his work in relation to irrigation is the most known in Great Britain, Garstin's position as the senior officer of the Ministry of Public Works in Egypt brought him in contact with many other forms of the public service. On his recommendation a geological reconnaissance of Egyptian territory was started in 1896, which soon developed into the present Geological Survey. The Survey of Egypt commenced in the Ministry of Public Works while he was in charge, and

he warmly supported the various scientific activities which grew up in connexion with it.

The Department of Antiquities has always formed a part of the same Ministry, and in its work and its responsibilities Garstin always took a keen interest. As soon as the Aswan Dam was decided upon, entailing the partial submergence of the island and temples of Philæ, he took measures for the complete underpinning of all parts of the buildings which were not founded on rock; and later, when the raising of the Dam became necessary, he obtained the allocation of a considerable sum for the execution of an archæological survey of that portion of the Nile Valley which would be submerged. The present Museum at Cairo is also due to his efforts to house safely the ever-increasing collections of Egypt's ancient civilisation

A keen sportsman, the wild fauna of the Sudan strongly attracted Sir William Garstin, from its inception he strongly supported and took an active interest in the Zoological Gardens at Giza

H. G. L.

We are indebted to *Science* of November 28 for the following details of the life and work of Prof. W. A. Locy, professor of zoology in Northwestern University, Illinois, who died on October 9 at the age of sixty-seven. William Albert Locy was born at Troy, Michigan, of Dutch ancestry, and received his early training in the University of Michigan. During the year 1884–85 he held a fellowship at Harvard, where he completed an embryological investigation on "The Development of *Agelena nævia*." In 1887 he went as professor of biology to Lake Forest University, where he remained nine years. During this period he published important papers on the embryonic development of the elasmobranchs, the derivation of the pineal eye, and the structure and development of the vertebrate head. In 1896 Locy succeeded Prof. E. G. Conklin at Northwestern University, where he remained until his death. His work there had two aspects, one, the developmental history of the sense organs, to some extent a continuation of his earlier researches; the other, the history of biological science. In 1908 he published a collection of historical portraits entitled "Biology and its Makers," which has since been translated into German, while in 1918 he produced "Main Currents in Zoology," and at the time of his death he was completing another work, "The Rise of Biology." The significance of his work on the history of science was recognised by his election as the first president of the History of Science Section of the American Association. He was also president in 1915 of the American Society of Zoologists.

We regret to record the death, at the age of sixty-seven, of Prof. J. Bergonié, professor at the clinic for medical electricity and biological physics in the University of Bordeaux. Prof. Bergonié was chiefly known for his work on electro-therapy. He was the author of numerous papers, and was for many years editor of the *Archives d'Électricité médicale*, in which journal most of his original publications appeared. Among the most important of his original contributions to medicine we may mention "Contributions à l'étude du phénomène physique du muscle" and "Physique du physiologiste et de l'étudiant en médecine" (1892). Prof. Bergonié invented an ingenious device for localising metallic foreign bodies in the human subject, which was used to some extent in the War. He also invented an apparatus designed to treat the condition of obesity. He died as a result of injuries associated with X-rays and radium. During the last few years he had been actively at work upon the anti-cancer centre at the Hôpital St. André, Bordeaux. He twice received the gold medal of the Carnegie Foundation.

In the issue of the *Physikalische Zeitschrift* for November 15, Prof. E. Warburg gives a sympathetic account of the life and scientific work of his former assistant and colleague, Karl Richard von Koch, who died a short time ago after having resigned the professorship of physics at the Stuttgart Technical School in 1919 owing to heart trouble. Prof. Koch was born at Stettin in 1852, and after studying at Bonn, Freiburg and Gottingen, graduated Ph.D. at Freiburg in 1875. While librarian there he commenced research in physics under Warburg, and was appointed lecturer in physics in 1881 and extra professor in 1886. In 1888 he became professor at the Aachen, and in 1891 at the Stuttgart Technical School. Here he designed the new Physical Institute, opened in 1910, which has since served as a model of what such an institute should be. His scientific work lay mainly in the direction of improving methods of measurement, especially in elasticity, but he took great interest in the application of physical principles to practical problems and to natural phenomena. His best-known researches are probably those on the elasticity of metals at high temperatures, on the determination of gravity, and on the auroræ.

We regret to announce the following deaths:

Prof. S. A. Beach, professor of agriculture at Iowa State College, who was known for his work on apple growing and whose name is included in the list of honorary and corresponding members of the Royal Horticultural Society, on November 2, aged sixty-four.

Mr. Alfred H. Brooks, for twenty years chief of the Alaskan Division of the United States Geological Survey, on November 21, aged fifty-three.

Dr. E. Hedinger, professor of pathological anatomy and histology in the University of Zurich, and formerly of the University of Basle, who, in 1914, undertook a special mission to South Africa to investigate trypanosomiasis in cattle, on December 24, aged forty-eight.

Dr. Theodore Hough, dean of the medical department and for seventeen years professor of physiology in the University of Virginia, who worked on the factors regulating breathing and on related subjects, aged fifty-nine.

Mr. A. H. Savage Landor, well known as a traveller and explorer in Tibet and China and also in South America, on December 26.

Mr. F. G. Newton, director of the Egypt Exploration Society's excavations in Egypt, on December 25, aged forty-six.

Dr. B. R. G. Russell, of the Imperial Cancer Research Fund, who made noteworthy contributions to our knowledge of tumour transplantation and of the respiration and carbohydrate metabolism of normal and cancerous tissue, on December 22, aged forty-four.

Current Topics and Events.

In the *Times* of November 14 a special correspondent in Berlin, dealing with the disarmament of Germany, stated that the German intention "to increase the frightfulness of war by new methods" was finding "its expression in the creation of a great laboratory attached to the Kaiser Wilhelm Institute near Berlin, the object of which is to study war from the scientific point of view" "This mysterious, powerfully equipped, and strongly financed laboratory," it was added, "works in close contact with several parallel institutions scattered over Germany, and especially with the Gas Testing Institute in Hanover" This allegation has been met by a letter from Dr H Freundlich, the Deputy Director of the Kaiser Wilhelm Institute, refused, he states, by the *Times*, and so published in the *Berliner Tageblatt* of December 16 Dr Freundlich states, in the most explicit terms, that neither in the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry, nor in any other Institute associated with the Kaiser Wilhelm Society, is there any work in progress that has the purpose of developing war from the scientific point of view, and that all work there undertaken is exclusively scientific and technical investigation for the industries of peace, and having nothing to do with the purposes of war. Finally, Dr Freundlich invites the correspondent of the *Times*, accompanied by any expert he may choose, to visit the Kaiser Wilhelm Institute, so that he may investigate fully the situation and the character and purpose of the work which is being there carried out. We cannot, of course, know the considerations which led the *Times* to decline to publish this very emphatic repudiation of a serious charge, yet it seems highly desirable that the invitation of the Deputy Director of the Institute should be accepted, and the results made known in Great Britain. What can be credited to our late enemies should be credited, and if there could be an assurance that the great Institute, which was, and is still, presided over by Dr Haber, is now entirely detached from scientific work relating to warfare, it would be welcome news to all who are waiting for additional signs of a real regeneration of Germany in heart as well as in economic prosperity

It is unfortunate that the mere mention of the word atom in a scientific lecture to which reporters are admitted now usually leads to sensational statements in the daily press, much to the annoyance of the lecturer and the detriment of scientific truth. This happened last week in connexion with a lecture delivered at the University of Leeds by Prof R Whiddington during a meeting of the Science Masters' Association The lecture consisted merely of a general account of the present position of atomic physics with special reference to the work of Rutherford and Bohr Prof Whiddington's allusions to his own work were made to indicate the lines along which investigation into X-ray electrons and vacuum discharges was being attempted in the University of Leeds, and to give those members of the audience who so wished, an opportunity of seeing the kind of apparatus used It is scarcely necessary to say that no extravagant claims of the kind suggested in a London newspaper were put forward by Prof. Whiddington or implied in what he said, and the most charitable explanation of the fantastic account published is that the reporter could not sufficiently well comprehend a lecture delivered to an audience consisting mainly of university graduates in science

The following presidents and recorders have been appointed for the meeting of the British Association to be held at Southampton on August 26-September 2: *Section A* (Mathematics and Physics)—President: Dr G C. Simpson, Recorder Prof A M Tyndall, University, Bristol. *Section B* (Chemistry)—President Prof C H Desch; Recorder: Dr H McCombie, King's College, Cambridge *Section C* (Geology)—President. Dr. W G Miller, Recorder: Prof. W. T Gordon, King's College, Strand, W.C.2. *Section D* (Zoology)—President: Mr. C Tate Regan; Recorder Mr. F Balfour Browne, Dysart House, Luard Rd, Cambridge *Section E* (Geography)—President: Mr A R Hinks, Recorder. Dr R N Rudmose Brown, University, Sheffield *Section F* (Economic Science and Statistics)—President (not yet appointed), Recorder. Prof H. M. Hallsworth. *Section G* (Engineering)—President: Sir Archibald Denny, Bart., Recorder: Prof. F. C Lea, University, Sheffield. *Section H* (Anthropology)—President: Dr. T Ashby, Recorder: Prof H J Fleure, University College, Aberystwyth *Section I* (Physiology)—President. Prof A. V. Hill; Recorder: Dr. J. H. Burn, Felden Close, Boxmoor. *Section J* (Psychology)—President: Prof C Spearman; Recorder: Dr Ll Wynn Jones, 7 St Mary's Avenue, Harrogate. *Section K* (Botany)—President: Prof. J. Lloyd Williams, Recorder: Mr. F T Brooks, 31 Tenison Avenue, Cambridge. *Section L* (Educational Science)—President: Dr. W. W. Vaughan, Recorder: Mr C. E. Browne, Christ's Hospital, West Horsham. *Section M* (Agriculture)—President. Dr. J. B. Orr; Recorder Mr. C. G T. Morison, School of Rural Economy, Oxford.

Of the many recent efforts made by British manufacturers to establish a home industry in the production of colouring matters, one of the most successful has been the enterprise started under the wise inspiration of Mr. James Morton, of the Morton Sundour Fabrics, Ltd., of Carlisle. Until 1914, this firm was entirely a dye-using undertaking dependent on continental sources for its supply of fast dyes The stoppage of German supplies of colours consequent on the outbreak of war led Mr. Morton to turn his attention to the production of these essential dyestuffs, and, gathering together a group of chemists, he encouraged them to work out the difficult problem attendant on the large-scale production of modern vat colours, a group of chemical substances having highly complicated constitutions. By the end of 1915, the intricacies of indanthrene blue and flavanthrene (indanthrene yellow) had been unravelled,

and these colours were being turned out on a manufacturing scale. Other dyes of the same class speedily followed. These persevering investigations were not, however, restricted to the imitation of foreign products. The chemists of the Sundour factory, with commendable initiative, extended the scope of their work to the search for entirely new colouring matters. Here again they achieved a noteworthy success in the discovery of a new group of dyes, known as the Caledon Jade-green series, for the typical representative of this group is unsurpassed for fastness and colouring power

A FURTHER important development is now announced from Scottish Dyes, Ltd., an offshoot of the Sundour firm. Processes have been discovered for rendering soluble the anthraquinone vat colours, in this way overcoming one of the disadvantages attending the use of these insoluble dyes. The process is being applied particularly to Caledon Jade-green, and the improved product is known as Soledon Jade-green. Similar soluble colouring matters can be obtained from other vat dyes of the anthraquinone series and render it possible to apply these colours to cotton and wool equally. In the case of the latter textile, this application will lead to a marked increase in the fastness of dyed woollen fabrics. The above-mentioned developments taken in conjunction with the industrial success which has crowned the recent investigations of chemists in other British colour factories demonstrate conclusively that scientific research is not merely a necessary but a profitable form of expenditure in all commercial undertakings dealing with chemical products.

AMONG the activities of the League of Nations, which celebrated its fifth anniversary on Saturday, January 10, are several of particular interest to workers in pure and applied science. The Transit Organisation of the League is engaged in work on matters concerning road traffic, inland and maritime navigation, telegraph, telephone and wireless facilities, calendar reform, etc. In the past year the Health Organisation has, in the words of the Fifth Assembly, "extended its sphere of action, improved, completed and defined its technical equipment, and is thus carrying out with increasing success its special task, which is to give effective help to the various national administrations in their campaign against epidemics and their attempts to improve public health." The Committee on Intellectual Co-operation, to which Prof. Einstein has returned, and M. Lugones, a distinguished Argentine *savant*, has been added, is organising and developing its work on bibliography, exchange of publications, inter-university relations, and the pooling and distribution of scientific information. This Committee held an extraordinary session in Paris on Monday, January 12, under the presidency of M. Henri Bergson (France). Prof. Gilbert Murray represented Great Britain, and other members of the Committee include Prof. Einstein (Germany), Mme. Curie (Poland), M. Jules Destrée (Belgium), Sir J. C. Bose (India), and Prof. R. A. Millikan (U.S.A.). The principal item on the agenda was the question of the organisation of the International Institute for Intellectual Co-operation, which was recently offered to the League by the French Government. The proposed Institute, which is to be established in Paris, will be under the direction of the International League Committee in Geneva, and it will be the duty of this Committee to draw up such rules and regulations for its organisation as will safeguard the international character of the Institute.

THE British Broadcasting Company's new high-power station 5XX is being constructed at Daventry, Northamptonshire. The site of the new station is in open country, about 600 feet above sea level, and 400 feet higher than the surrounding land. A "T" aerial will be used, and an 800-foot and a 500-foot mast are being erected, the transmitter being situated directly under the centre. The antenna has been designed so that its natural wave-length should be about 1600 metres, which is to be the wave-length used for transmission. The power rating is nominally 25 kilowatts, but the actual power used at the station will be 100 kilowatts. The earth system consists of a circular metal plate laid underground and has a radius of 100 feet. It will be connected with the London studio 2LO by means of an overhead telephone line, but an emergency underground cable will also be installed. It is expected that good crystal reception will be obtained up to a radius of about 100 miles. Transmissions will take place in the afternoon and evening. Special programmes of its own will be provided two days of the week, a relayed provincial programme on a third day, and relays of the London programme for the remainder of the week. The first programme will take place in a few months' time.

IT is evident that the visit of the Parliamentary Commission to East Africa, referred to in our leading article of January 10, has had some effect in directing the attention of the colonial governments to the cause of scientific research. By a happy coincidence, while Major A. G. Church was making a plea for greater encouragement for scientific institutions at the St. Andrew's Dinner at Mombasa, the Governor of Kenya Colony, Sir Robert Coryndon, at the corresponding function in the capital, made the same appeal and made use of the same illustration, namely, the Amani Institute. He stated that Kenya Colony is much behind the times so far as scientific research is concerned, and particularly in the investigation of human and animal disease, in botany and in ethnology, and there is lack of co-ordination amongst the East African Colonies on such questions. Sir Robert said that scientific workers in Kenya are too few, that they are working under very difficult conditions, and he would welcome the establishment of a central laboratory in which scientific problems could be properly attacked. Regarding the Amani Institute of Tanganyika, he deplored the fact that nothing has been done since the War to develop the work begun by the Germans, and upon which many thousands of pounds was spent by them. In paying

a tribute to the work of Dr van Someren, who was responsible for the building and the collections of the Natural History Museum of Nairobi, the Governor made an appeal for the support of public-spirited men for the upkeep and improvement of that institution, laying stress on the fact that the cultural aspects of life must play an increasingly important part in the affairs of Kenya Colony

A PARTY of 32 undergraduates from the Engineering Departments of the University of Cape Town are at present on a tour in England Accompanied by eight members of the staff, including Profs Bohle, Plant, McMillan, Snape, and Boyd, they arrived in London on December 31, and their stay will extend over five or six weeks The objects of the tour are to bring the students into close touch with British manufacturers and to give them a broader outlook on life in general. The whole trip has to be completed within the long summer vacation The first fortnight has been spent in the London district, where, in addition to visiting the historic buildings, special visits have been made to the National Physical Laboratory, Science Museum, Woolwich Arsenal, and to some important firms From London the party proceeds to Birmingham, Manchester, Preston, Liverpool, Newcastle, and Sheffield Each student has to submit a report of the tour which, if the professor of mechanical engineering considers satisfactory, will count in lieu of the six weeks' vacation workshop course usually taken in the summer Many of the students from Cape Town after finishing their four years' course come to England for experience in works, and remain here While there are a fair number of openings for civil engineers in the Public Works and Irrigation Department of the Union Government it is more difficult for electrical and mechanical engineers to find employment in the colony. In organising this unique tour, the Dean of the Faculty of Engineering, Prof H Bohle, has been assisted by the staff of the High Commissioner of the Union of South Africa and the officials of the Union Castle Mail Steamship Company, and as a result it has been possible to carry out the complete trip, lasting twelve weeks, for 65*l.* a head.

THE disappearance of seals of economic value from their more accessible breeding-places, under the pressure of the seal-hunter, has intensified their destruction in more remote areas From some of these they have already been exterminated — the fur-seals (*Arctocephalus australis*) and sea-elephants (*Macrorhinus leoninus*) of Gough Island have all but gone—and there is a danger that in their other southern haunts such seals and the less valuable Weddell, crab-eating, and Ross's seals of the Antarctic circle may ultimately be reduced to the vanishing point We therefore welcome the announcement (*Times*, January 6) that the French Government has decided to create a preserve for seals and for penguins, which are destroyed wholesale in some areas for their feathers and oil, on the territories belonging to France in the Southern Ocean. These include Kerguelen, the Crozet Archipelago, St. Paul and Amsterdam islands, and the Adélie Land sector of the Antarctic continent. In these areas the destruction of seals and penguins will henceforth be illegal The crux of the efficacy of animal sanctuaries, however, lies in the proper enforcement of the law, and we doubt whether the policing of these widely scattered scheduled areas by naval patrols based on Madagascar, as is proposed, will be so thorough as one could wish to see

EVERY one familiar with astronomical and other optical instruments will see with regret the announcement that the old-established firm of Sir Howard Grubb and Sons, Ltd, St Albans, and formerly of Dublin, has gone into voluntary liquidation, and is for sale The business was founded in Dublin early in the nineteenth century by Sir Howard Grubb's father, the late Mr Thomas Grubb, F R S, who was engineer to the Bank of Ireland and designed and constructed the machinery for the manufacture of the bank notes. Although made seventy or eighty years ago, this machinery was still in use four or five years ago and probably is so still A number of machine tools, such as lathes, planing, engraving, wheelcutting and dividing machines, were made by the firm, as well as many portrait lenses The works were moved from Dublin to St Albans in 1918 in connexion with the manufacture of periscopes for British submarines Among the important astronomical instruments made by the firm are the following. 27-inch refractor and dome for Vienna, 26-inch photographic refractor for Greenwich, 24-inch photographic refractor with 18-inch guiding telescope for Cape Town, and a similar instrument for the Radcliffe Observatory, Oxford, with dome and rising floor; 26-inch refractor for Johannesburg, mounting for 24-inch refractor for Santiago, Chile, 40-inch reflector for Simeis, Crimea, 7-metre solar spectrograph for Pulkovo, the 13-inch photo telescopes with 10-inch guiders for the International Photographic Survey of the heavens, erected at Greenwich, Oxford, Dublin, Cork, Capetown, Mississippi, Melbourne, Tacubaya (Mexico), Perth (W.A), etc. It is greatly to be deplored that a firm with such a record of splendid work, and a reputation so high among optical instrument manufacturers, should have lacked sufficient support to keep it in existence as a profitable concern.

THE late Prof. John Milne, the distinguished seismologist, was among those commemorated a few days ago in a ceremony at Tokyo in honour of living and dead foreign benefactors of Japan.

A SERIES of six Hunterian lectures on "Recent Discoveries of Fossil Man" will be delivered by Sir Arthur Keith at the Royal College of Surgeons of England on January 19, 21, 23, 26, 28, and 30, at 5 o'clock each day.

THE Council of the Geological Society has this year made the following awards:—*Wollaston Medal*: Mr G. W. Lamplugh; *Murchison Medal*: Dr. H. H. Thomas; *Lyell Medal*: Mr J. F. N. Green; *Bigsby Medal*: Mr. C. W. Knight; *Wollaston Fund*: Dr. A. Brammall; *Murchison Fund*: Dr. A. E. Trueman; *Lyell Fund*: Dr. J. A. Thomson and Dr. W. A. Richardson.

WITH reference to the note in our issue of January 10, p. 60, on the proposed motor tours across the western Sahara to Timbuctoo, organised by Citroën Cars, Limited, it is announced that as absolute security cannot be relied upon along the Colomb-Bechar—Timbuctoo route, the opening of the service between the two points has been suspended for a period of at least one year.

APPLICATIONS are invited by the Metropolitan Asylums Board for the two following appointments, namely, the directorship of the board's pathological services and that of their diphtheria antitoxin establishment Particulars of the appointments and forms of application can be obtained from the Clerk of the Board, Victoria Embankment, E C 4 The completed forms must be received not later than the morning of Wednesday, January 28

APPLICATIONS are invited for the post of an assistant agricultural chemist for the Division of Research, Lands and Forests Department, Sierra Leone Candidates must hold an honours degree in natural science (chemistry being the principal subject), or associateship of the Institute of Chemistry, and a diploma in agriculture Further particulars and the form of application are obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S W.1

MR RICHARD H. BURNE has been awarded the Honorary Medal of the Royal College of Surgeons of England for "services rendered to the advance of biological knowledge." Mr Burne has greatly extended the Department of Comparative Physiological Anatomy in the Museum of the College, of which department he is the Curator The medal thus awarded, although founded in 1802, has been awarded only eleven times previously. The list of former recipients includes the names of Sir Richard Owen, Sir James Paget, Lord Lister, and of Sir R. Havelock Charles.

Our Astronomical Column.

THE SOLAR ECLIPSE OF JANUARY 24.—This eclipse cannot be regarded as of great importance for the study of solar physics, owing to the unfavourable season of the year, and the rather low altitude of the sun at all the land portions of the track of totality The eclipse derives some interest, however, from the populous regions which it traverses in Canada and the N E corner of the United States, including some outlying districts of New York

Efforts have been made to induce the general public to join in the observations; in particular, to note the exact duration of totality at numerous points close to the northern and southern limits This will enable the exact position of the lunar node to be determined, as Newcomb did from similar observations in England in 1715 Numerous observatories lie within the totality track, so that full advantage will be taken of any opportunities for useful work that weather conditions may afford The altitude is too small for study of the Einstein shift, which was, moreover, dealt with sufficiently in 1922

The eclipse has some interest in the British Isles from the fact that, after a barren interval of two centuries, there is a very near approach to totality at St. Kilda in the Western Hebrides The sun's altitude is, however, insufficient for any useful work, and landing on St. Kilda is generally difficult in winter. There is a large eclipse throughout the British Isles, beginning about $14^h\ 45^m$, and greatest phase an hour later. The magnitude reaches 0 94 at Glasgow, 0 82 in London.

It would seem that the only observation of value that can be made in Britain is the careful timing of the first contact. Dr. Innes proposed a useful method of improving the determination by frequent measures of the distance between the cusps for the first minute or so. If the projection method be employed, two observers can mark on the screen the positions of the North and South cusps at prearranged beats of the clock. This method was found practicable at Greenwich in April 1921.

WOLF'S COMETARY OBJECT OF DECEMBER 22.—Observations of this object on December 22, 23, 25, 26 are now to hand. Dr. A Kahrstedt, of Berlin-Dahlem, has deduced the following (still very uncertain) elliptical orbit from the first 3 positions (Copenhagen Circular, No 56)

T	1925 March 27 7308 G M T (new)
ω	219° 32′ 38 0″
Ω	264 47 14 8
i	14 47 11 3
ϕ	40 27 44 4
μ	319 231″
log a	0 69726
Period	11 12 years

The magnitude is estimated as 16 The approach to the sun will probably cause a slight brightening, but the distance from the earth is increasing. The object will remain observable for some months

EPHEMERIS FOR GREENWICH MIDNIGHT.

		R A	N Decl
Jan	14 0	$4^h\ 6^m\ 4^m$	20° 0′
	22 0	4 10 2	18 38
	30 0	4 16 4	17 29
Feb	7 0	4 25 0	16 31

The object is in Taurus, moving towards Aldebaran The elements have some resemblance to those of Faye's Comet, due at perihelion next September Identity, however, does not appear to be possible.

INTERESTING GROUP OF MORNING STARS.—Mr W. F Denning writes "On the morning of Thursday, January 22, the south-eastern sky before sunrise will display the planets Mercury, Venus, and Jupiter, and the crescent of the moon in near companionship. The picture will be a rare and interesting one, but it will not be easy to observe, for the planets involved will rise at about 6 h. 35 m, and this is only 1 h. 20 m. before the sun They will be placed, therefore, very near the horizon, and will require a favourable atmosphere at low altitudes in order to be well seen. If the observer occupies a position commanding a good open view of the south-east, and if weather conditions are good, there should not be much difficulty in detecting the various objects, though twilight will be strong The best time to look for them will be at about 7 A.M. or a little afterwards. Of the planets, Venus will be the most brilliant, Jupiter being next, and Mercury last in the order of magnitude."

Research Items.

ARCHÆOLOGICAL EXPLORATION IN FLORIDA.—Mr. J. Walter Fewkes has been able to take advantage of the commercial exploitation of Weeden Island, Tampa Bay, to explore the shell mounds, which were noted nearly half a century ago as a prominent feature of this part of Florida, but have now to a great extent disappeared owing to the use of their material for road metal. In vol. 76, No. 13, of the Smithsonian Miscellaneous Collections, Mr. Fewkes describes and figures remains found in a preliminary exploration on Weeden Island, which was mainly directed to the investigation of a mound which had been used as a cemetery. The prehistoric aborigines appear to have lived principally on shell fish, but they also ate fish, game, and rodents, and, possibly, roots and fruits. The mound exhibited three layers of stratification, one being modern. In the upper of the two ancient strata, skulls and skeletons occur in numbers, and the implements and a finely decorated pottery point to a relationship with the prehistoric inhabitants of Northern Florida and Southern Georgia. The lowest stratum contains objects belonging to an ancient people of Florida whose origin and affinities are obscure, but whose pottery suggests affinity with the archaic pre-Taínan Ciboney culture of Cuba and the similar early cultures of other West Indian Islands. Whether it was autochthonous in both areas or an extension from one to the other is a question for future investigation.

CLASSIFICATION OF CONSCIOUSNESS.—The presidential address to the Section of Psychiatry, Royal Society of Medicine, delivered by Dr. C. S. Myers, has been printed in the *Lancet* of November 29. Dr. Myers puts forward certain views and aspects, derived from a study of pure psychology, in the hope that they may prove interesting and suggestive to those working in the applied field of medical psychology. He reviews some of the more fundamental problems of psychology, which have of recent years been less frequently considered than before the War, owing to the urgency of more practical problems. Nevertheless it is wise at intervals to view the more abstract problems. Dr. Myers considers the conception of consciousness and discusses the difficulties involved in the usual classification into the three modes, namely, the cognitive, conative, and affective, and offers an alternative scheme. He then outlines the part played by consciousness and shows that its function is to select both from alternative responses and alternative stimuli so as to maintain an environment—whether physical or mental—that shall be favourable, and to avoid one that is unfavourable. For this to be possible, it is necessary that relatively small variations in the environment should differ in the reactions evoked. He shows how the vague complex precedes the differentiated simple and the part played by the power of projection, *i.e.* the ability of the self to regard its own change of states as something outside itself. The reflex act is interpreted not as an original type out of which more complex forms of activity have evolved, but as a decadent form of mental activity. Dr. Myers concludes with a discussion of the relation of consciousness to the brain, and points out that the recent developments of physical science have rendered the difference between mind and matter a different problem from what it was a hundred years ago.

THE BIOGENETIC LAW AND THE GYMNOSPERMS.—The very characteristic and stimulating paper that Prof. E. C. Jeffrey of Harvard read before Section K of the British Association at Toronto, and at Edmonton, is printed in *Science* (vol. 60, No. 1563, December 12, 1924), and will certainly arouse interest amongst European botanists, possibly provoking the retort courteous, from the European view-points so vigorously assailed. To Prof. Jeffrey, the higher plants provide excellent examples of the validity of the doctrine of recapitulation, their witness being free from the obscurities introduced by "larval forms." He cites particularly the normal leaf form to be found in seedling stages of xerophytic Cacti, Veronicas, etc., as also the typical leaves on seedlings of plants later armed only with phyllodes or phylloclades, and the prevalence of the typical evergreen needle upon the seedling conifer, although later these plants may be deciduous, as on larch, or bear leaves confluent with the surface of the stem, as on the arbor vitæ. Prof. Jeffrey then proceeds to discuss the anatomy of living and fossil forms amongst Gymnosperms, and thus finds evidence for three "working principles," namely, (1) recapitulation, (2) the doctrine of retention (instanced by conservative organs, namely, root and reproductive axis); (3) the doctrine of reversion as a result of injury. In analysing the anatomical and fossil data along these lines, Prof. Jeffrey fights over again the phyletic battle of Araucarian phylum versus Abietinean as competitors for ancient standing amongst Gymnosperms, and concludes once more that "when the dust of conflict has settled, it will probably appear that Ginkgo and Pinus stand side by side as the prototypes of Mesozoic gymnosperms of Cordaitean derivation. It will then be realised that Agathis and Araucaria are aberrant extremes, which merely simulate Cordaites on the basis of extremes meeting but have no near affinity with them."

THE COOLING OF THE EARTH.—In the Journal of the Washington Academy of Sciences for December 4, 1924, Leason H. Adams, of the U.S. Geophysical Laboratory, presents a very welcome discussion of the distribution of temperature at moderate depths within the earth. He adopts the method initiated by Holmes in 1915 of utilising the age of the earth as a known factor in the problem. This makes it possible to determine the relative importance of the heat generated by radioactive disintegration, and thus to calculate the internal temperatures from an assumed initial molten state. Cooling at first is controlled almost entirely by convection giving a thermal gradient of nearly 1° C. per km. Convection is gradually terminated either by crystallisation, leading to a gradient of 2.5° to 5° per km., or by increasing viscosity, leading to a gradient less easily calculable, but lying within the range 1° to 10° per km. As a probable average, 4° per km. is adopted for the final computations. These are based on the assumption that below the outer 100 km. the material produced by crystallisation-differentiation would be peridotite, a diabasic zone forming above, and finally a granitic layer. The important principle is then established that on account of the great age of the earth (1600 million years), the temperatures at depths greater than 100 km. are unaffected by any reasonable variation of the initial temperatures in the upper 100 km. For the purpose of calculation, an initial surface temperature of 1200° C. has commonly been adopted (*e.g.* by Holmes and Jeffreys), and it has been argued that, as the surface was probably of granitic composition, a much lower initial temperature would more accurately fit the conditions. However, as the present temperatures depend on the original temperatures at considerable

depths, it is easily seen that 1200° C., far from being too high, is more probably too low. The author takes 1400° C., the melting-point of peridotite, as the effective initial temperature, and gives a temperature curve down to 300 km., which is the best representation of the probable average thermal conditions under the continents yet available.

THE PHOTOELECTRIC PRIMARY CURRENT IN CRYSTALS.—A paper by Messrs. B. Gudden and R. Pohl, in the *Zeitschrift für Physik*, December 6, deals mainly with the positive portion of the photoelectric primary current which is produced by the action of light of long wave-lengths, or thermal molecular movements, on a crystal in which light of short wave-length has caused a flow of electrons to the anode, leaving the positive ions in their original positions in the lattice. The effect has been studied in diamond, with light of a number of different wave-lengths produced by a monochromator, and it appears that wave-lengths of 630-660 $m\mu$ are most effective in producing it. The optical absorption of diamond extends farther towards the red, when the disturbances in the lattice are increased by the positive charges which remain fixed in the lattice after the negative portion of the photoelectric primary current has passed. The authors formerly regarded the primary current as being wholly due to this flow of electrons to the anode; but they now include the positive portion of the current in this term. With blue light, for example, it is shown that part of the primary current is due to the flow of electrons, without inertia, and part to a shifting, step by step, of the resulting positive charges towards the cathode, due to thermal molecular movements. These facilitate the passage of an electron from a neutral atom to the positive ion standing next to it on the side towards the anode. It is probable that, so far as the conductivity mechanism is concerned, the photoelectric phenomenon can be dealt with in the same manner, not only in other crystals in the author's first group, with refractive indices more than two, but also in second group crystals, such as sodium chloride which has been treated with X-rays.

MAGNETISM OF THE COILS OF MOVING COIL GALVANOMETERS.—It has been known for many years that the magnetic properties of the materials used for the suspended systems of moving coil galvanometers have much to do with the troublesome "zero shift" which often greatly increases the labour of the observer. The British Scientific Instrument Research Association (26 Russell Square, London, W.C. 1) has, therefore, done good work in publishing a careful investigation (price 6*s.*) on this subject by Mr. G. Williamson. The author finds that zero shifts can be divided into two kinds: first, those due to temperature changes and, secondly, those following upon deflexions of the coil. The first cause is due to variations in the elastic constants of the suspended strips. The second cause is due to the permanent magnetism of the constituents of the coil. The author makes an exhaustive study of this second cause. He uses two methods of obtaining rough comparative estimates of the permanent magnetic properties of similar specimens. In the first method, he magnetises the specimen by a known strong field and then measures the couple exerted on it by a weaker field perpendicular to the direction of magnetisation. In the second method, he measures the zero shift of the specimen following on a deflexion in a known constant field. He finds that all the materials forming the galvanometer coil—silver wire, wooden former, silk insulation, the mirror itself—showed permanent magnetism. Of the resultant effect, 18 per cent. was due to the wooden former, 33 per cent. to the silk insulation, and the remaining 49 per cent. was due to the silver wire, mirror, binding wires, etc. Some of the effects due to the silver wire could be minimised by heating it in concentrated hydrochloric acid, and the ferro-magnetic effects due to the wooden formers could be diminished by exposing them to hydrochloric acid gas. The silk insulation was much the most difficult to deal with. It was found that the ratio of zero shift to sensitivity diminishes as the magnetic field (*i.e.* the sensitivity) increases.

BEESWAX.—The production, properties and uses of beeswax are described in the *Chemical Trade Journal* for December 12, 1924. Beeswax is formed voluntarily by the bees loading their stomachs with honey and then resting in clusters perfectly still for twenty-four hours. Owing to the introduction of artificial honeycombs in bee culture, European countries have failed to cope with the modern demand, and large quantities of wax are imported from Africa, the West Indies, and Portugal. The imported material is mostly produced by wild bees and is inferior to the product obtained from the home-cultivated bee. The wax is often bleached by exposure to the sun or ozone (extensively used at Leningrad) or by other oxidising agents. The principal constituents are myricyl palmitate and cerotic acid; smaller quantities of myricyl and ceryl alcohols, psyllostearyl alcohol, melissic acid, many hydrocarbons (*e.g.* heptacosane hentreacontane) and unsaturated acids are also present. The physical properties are described in detail, a table of constants being given.

SYNTHETIC SWEETENING COMPOUNDS.—The chemistry of synthetic sweetening compounds is reviewed by G. M. Dyson in the *Chemical Age* for December 6, 1924. The recent researches of Cohn and Holleman are described. The introduction of halogen and other groups into saccharin has the following general effects. The sweetness increases with decreasing molecular weight of the entering halogen group, though nearly all halogen derivatives have a bitter after-taste. 6-Chlorosaccharin is more than half as sweet as saccharin itself, and is sweeter than the 4- and 5-chloro-derivatives. Whereas 4-amino-saccharin is sweeter than saccharin, 4-nitrosaccharin is bitter. The introduction of alkyl groups has little or no effect, though the after-taste is modified. Multiplication of sweetening groups is not always associated with an increase of sweet taste. Sternberg has pointed out that for an aliphatic compound to be sweet, the alkyl groups must not outnumber the hydroxyl groups by more than one; further, the sweetness of an aliphatic compound increases with the number of hydroxyl groups present. Oertly and Lyers have proposed a theory of taste akin to the colour and constitution theory, but the rules are more often broken than followed. Mr. Dyson describes in some detail the preparation of saccharin, and mention is made of "dulcin" and "methyl-dulcin," which are *p*-phenetyl urea and *p*-anisyl urea respectively.

CONDUCTIVITIES OF ELECTROLYTES.—Researches on measuring the conductivities of electrolytes by the induced magnetic field method of Guthrie and Boys have recently been carried out by O. Scarpa (*Gazzetta Chimica Italiana*, November 1924). Adopting this method the author investigates the electrical resistance of, and the influence of a magnetic field on, an electrolyte in motion. The action of a magnetic field on a jet of an electrolyte carrying a current is also described.

The Physical and Optical Societies' Exhibition of Apparatus.

THE fifteenth annual exhibition of apparatus held by the Physical and Optical Societies at the Imperial College of Science and Technology, South Kensington, brought to light a larger number than usual of novel and improved instruments. The standard of workmanship and finish was everywhere high, and it was a pleasure to note that the products of British firms, to which the exhibition was primarily devoted, compare very favourably in these respects as well as in ingenuity and soundness of design with imported goods of a similar character. There was a preponderance of instruments for industrial purposes and for advanced research; a certain number of firms also showed apparatus suitable for educational laboratories, but a greater proportion of apparatus of this type would be welcome at such an exhibition. Special interest also attaches to disassembled instruments; a brass box with knobs is impressive rather than instructive.

In briefly discussing some of the exhibits it is impossible to do justice to most of the stands, which could not be adequately studied in an exhibition lasting only two days. It will be necessary to make an arbitrary selection of apparatus which appeared to be specially interesting on account of its novelty, and to pass over without mention a majority of items the intrinsic importance of which is at least as great.

The most sensational feature of the exhibition was Mr. C. F. Elwell's discourse on "Talking Motion Pictures," illustrated by demonstration films. It must suffice here to remark that no one who saw and heard the demonstration can doubt that the essential problem has been solved, and that for better or worse the talking picture is ripe for commercial exploitation. In addition to other items making for brighter physics, visitors had the piquant experience of being addressed by a very realistic President Coolidge on the American citizen's burden of taxation! An equally interesting discourse and demonstration was given each day by Mr. F. Twyman, who dealt with the Michelson interferometer. In the hands of Mr. Twyman and his assistant, this interferometer became a delicate means for studying temperature distribution in a transparent body: the instrument was so adjusted as to project on the screen a field of substantially uniform colour derived from a source of white light, and on the introduction of the demonstrator's finger into one of the interfering light-beams, lines of colour appeared round the shadow of the finger, these lines representing approximately isothermal contours. Perhaps the most striking of the experiments shown was the "soaking in" of the isothermal lines into a plate of glass when a match had been momentarily applied to the latter, and it was also made possible to "see" petrol vapour poured from a bottle and the lines of strain in glass under stress—the latter application giving effects similar to those which have been obtained by Prof. E. G. Coker with polarised light.

The Cambridge Instrument Company is one of the firms which enters into the spirit of the exhibition and seeks to enhance its interest by the variety of its exhibits and by admirable descriptions given in the programme. The principal *métier* of the firm, the measurement of temperature, was represented by some dial thermometers of the vapour-pressure type, but they were somewhat overshadowed by more intriguing "side-lines." The dial thermometer appears to be displacing the glass thermometer from industry, for Negretti and Zambra also made a feature of thermometers in which a mercury bulb communicates with a dial-control through steel-lined tubing. An interesting improvement in calorimetry is the use of stainless steel in a bomb calorimeter (Griffin). For taking the temperature of buried cables, Siemens measures the resistance of a nickel pilot wire fitted to the latter.

Items of interest to meteorologists included an Assmann psychrometer ventilated by an electrically driven centrifugal fan, shown by Negretti and Zambra. It is to be hoped that this or a similar firm will succeed in solving the hitherto unsolved problem of constructing a self-acting hygrometer with permanent zero; apart from this latter consideration the firm's recording hair hygrometers appear to be fool-proof. A simple and ingenious recording barometer of great sensibility (Hughes) is that designed by S. G. Starling: the mercury bulb is connected to the vertical column of the barometer by a horizontal tube of substantial length, the whole being mounted on a pivoted board hanging in a vertical plane. Movement of the mercury causes the board to tilt, while a pen carried by the board traces a record on a chronometric drum. Short and Mason, by a special design of the linkwork controlling the pen of a barograph, are able to provide the latter with an exceptionally open scale. A novel kind of cloud photograph is taken with the Robin Hill lens (Beck), which has an angle of 180°, so that a photograph of the whole sky can be taken on a single plate. Such a photograph is of value in spite of its distortion, but if necessary a selected section of it can be straightened out by copying with the lens reversed.

Two interesting oscillographs were those shown respectively by Tinsley and Co. and by the Cambridge Instrument Co. The former is of the inertia-less cathode-ray type and employs a hot cathode, high sensibility with low voltage being thus secured. The cathode stream is focussed into a pencil by surrounding the filament with a positively charged sheath. The Cambridge instrument, on the other hand, is an improvement on the Duddell oscillograph and enables simultaneous records to be obtained from three separate vibrators which are replaceable and may be electrostatic or electromagnetic in any combination. Intense illumination is secured by applying a momentary excess voltage to the 4-volt metal filament lamp during and immediately before exposure of the travelling photographic film. The Campbell frequency meter, which aroused much interest when it was recently described before the Physical Society, was also shown by this firm. It depends on a bridge system employing mutual inductances, covers a range of from 200 to 4000 cycles, and attains an accuracy of about 1/10 per cent. Other meters worth noting were a series for various quantities (ammeters, voltmeters, etc.) but uniform exterior by the Weston Electrical Instrument Co. These are of convenient square form but comparable in price with those of less portable design. A very interesting detail of design has been introduced into the Cirscale moving-iron instruments (Record Electrical Co.) in order to secure a pointer movement of 300°. These instruments are of the type in which a pair of soft iron strips inside a solenoid are magnetised by the same field, so that the repulsion between them measures the energising current. In the present instance, two pairs of such strips are used: one member of the first pair is fixed, while the "fixed" member of the second pair is carried round by the moving member of the first pair, the two latter members being rigidly joined together but spaced apart along the axis of the solenoid. The Rayworth's voltmeter (Elliott Bros.) for testing accumulators is provided with a

differential winding and a cadmium electrode so arranged that, in addition to ordinary testing, comparison of the potential of each plate with that of the cadmium electrode can be carried out, and further, the unexpended charge remaining in the cell can be measured. The Darimont electric batteries have the interesting feature that the exciting and depolarising solutions are separated by a semi-permeable membrane created by the reaction which takes place between the solutions themselves

For testing overhead A.C. mains, Crompton and Co. provide a hinged-core transformer. The ring-shaped core is passed over the main and closed so as to surround the latter, which then forms the primary of the transformer, while the winding on the core forms a secondary and enables the current in the main to be tested. Impedance apparatus included the Duwatcon condenser for wireless (Dubilier Condenser Co.), so designed that its range for series connexion slightly overlaps its range for parallel connexion, thus obviating the gap in tuning range which ordinarily occurs when the connexion is changed, and three interesting variometers. Of these the Mansbridge is flat in shape and comprises D-shaped coils: used alone it will cover all the B.B.C. wave-lengths, and in conjunction with a fixed condenser of 0·002 μf will cover wave-lengths up to 1800 metres. A similar range is attained in a variometer by the Marconiphone Co. by means of a series-parallel switch. In the "wound on air" variometers of the Igranic Electric Co. the windings are spherical and entirely self-supported.

Amongst wireless apparatus, the Multivibrator wavemeter designed by D. W. Dye (Sullivan) attracted much attention. In this arrangement a specially constant tuning-fork, maintained in vibration by a thermionic valve, controls by accordance a multivibrator comprising two valves so cross-coupled as to generate oscillations rich in harmonics at approximately the same fundamental frequency as the fork. By selective amplification, harmonics up to the 120th can be picked out and heterodyned with the oscillation the frequency of which is to be measured, and by using two such arrangements in series a harmonic of frequency $1{\cdot}2 \times 10^6$ can be utilised. A complete "public address system" for amplifying speech or gramophone reproductions was shown in action by Marconi's W. T. Co., high-power water-cooled valves as used for broadcast transmission by the M.O. Valve Co., and the newest types of dull-emitter and other valves by the latter, the Mullard Radio Valve Co., and Cossor. A fool-proof emergency wireless transmitter for ships' lifeboats was shown by Evershed and Vignoles.

As regards line telegraphy, it was gratifying to notice a column printer of British manufacture (Creed and Co.). Morse line currents are converted to printed matter arranged in columns like that given by an ordinary typewriter, as in the American instruments which have hitherto held the field. The direct-working sounder of the India Rubber, etc. Works Co. introduces the long overdue reform of replacing the pony sounder by a far more efficient device employing a diaphragm.

A radium clock has been devised by Mr. Harrison Glew the radium for which may be that contained in an ordinary applicator or other container which can be removed from the clock when desired: in fact, the period of the clock may be used as a measure of the quantity of radium in any vessel to which it is connected. An interesting high-voltage high-resistance battery useful in radio-active and ionisation work is the disc battery designed by Major C. E. S. Phillips (Cambridge Instrument Co.). It consists of adjacent paper discs coated with metal foil, is very portable, and is not damaged by short-circuiting. The horrors of the dentist's chair may be shortened by the use of radiography in the apparatus provided by Watson and Sons all external high tension leads are eliminated for the benefit of dentists untrained in such matters, and for the peace of mind of their patients. A Potter Bucky diaphragm is also provided for cutting out secondary radiation from the patient's body, which otherwise impairs the definition of the radiograph: it consists of a grid of lead plates so arranged as to absorb radiation which deviates from the direct line, and it is kept in motion during exposure so that its shadow does not appear on the film.

A soft-ray tube for crystal work, designed by Shearer, was shown by Hilger connected with a highly efficient evacuating arrangement. This comprised a Hyvac backing pump (on the Gaede model but with optically perfect contact surfaces) in combination with a Vitreosil mercury condensation pump (Edwards and Co.) with a fused silica casing, the over-all speed being about 200 c.c. per second and the ultimate vacuum about 0·000002 mm. An even faster pump is the Kaye-Backhurst, which is all of metal and employs an *annular* jet of vapour from boiling mercury to entrap molecules diffusing from the evacuated space. The speed amounts to some thousands of cubic centimetres per second.

Messrs. Hilger also showed how to use a Lummer-Gehrcke plate in combination with a spectroscope to demonstrate the Zeeman effect, obtaining very clear definition. Other optical items were a Nicol prism of 1¼-in. aperture (Bellingham and Stanley), a scaleometer (Ottway and Co.) comprising a pocket microscope with a scale in the focal plane of the eyepiece and an oblique glass plate for illuminating the object, and a rod illuminator (Baker) for microscopes. The latter very curious and effective device consists of a thick glass rod bent to any convenient shape and capable of carrying light by total internal reflection from a light source to a microscope: in fact it forms a kind of hose for conveying light. A selenium photometer (Watson and Sons), recently described by Dr. Toy, has been specially designed for measuring the density of photographic negatives. Two beams of light from the same source reach a selenium cell by different paths, and a screen can be turned so as to cut out one beam and let in the other at the same rate. The negative is interposed in the path of one beam and an adjustable wedge in that of the other, so that when the opacities of these obstructions are equal, no change in the illumination of the selenium cell is produced by turning the screen.

Teachers will be interested to find that kinematograph projectors for private use are coming within the reach of small pockets. A Pathé projector (Baker) can now be obtained at a comparatively moderate price, while a more expensive outfit (Kodak) enables the user to take his own films as well as to project them, the films being reversed to positive without the use of a negative. A Leitz photomicrograph (Ogilvy and Co.) has been so arranged that all the operations necessary in photographing microscopic objects on a whole plate can be performed from a single position of the observer, and the apparatus is suspended on springs while the exposure is actually being made. While discussing optical apparatus it is worth while to note that pointolite lamps can now be obtained for use on A.C. mains.

A very simple planimeter shown by Harling consists of a single rigid piece of metal carrying a tracing point at one end and a hatchet-shaped projection, the plane of which passes through the point, at the

other. The point is passed round a closed curve in the ordinary way, and the distance between the positions of the hatchet edge before and after this operation is a measure of the area encompassed It is claimed that this simple device can give an accuracy of 2 per cent.

Surveying instruments included a tacheometer (Cooke, Troughton and Simms) in which the horizontal distance of a surveyor's vertical scale is given directly, allowance for the slope being made by an automatic cam-operated adjustment of the distance between the stadie lines in the focal plane of the eyepiece with which the image of the scale is compared Dr Hutchinson's goniometer (Swift and Son) was also worth noting on account of its versatility it serves as an ordinary goniometer, an axial angle apparatus, a Kolrausch total reflectometer, and a prism refractometer. An ingenious balance (Oertling and Co.) called the "Chainomatic" dispenses with all weights and riders below 0·1 gm. by employing a chain attached at one end to an arm of the balance and at the other to a pillar which can be raised and lowered to a measured extent without opening the case The position of the pillar indicates how much of the weight of the chain is being borne by the balance arm In the tank gauge made by Negretti and Zambra for indicating liquid levels, air is pumped into a tube extending down into the liquid until it escapes from the bottom the tube is then put into communication with a pressure gauge which registers the head of liquid in the tank Another instrument of mechanical interest is the recording accelerometer of the Cambridge Instrument Co., in which an eccentric mass, the movements of which are made deadbeat by Foucault-current damping, records accelerations by the "stylus-on-celluloid" method developed by this firm

A fuller account of many of the exhibits will be found in the December issue of the *Journal of Scientific Instruments* published by the Institute of Physics. The issue is entirely devoted to the South Kensington exhibition

The following firms participated in the exhibition: C. Baker (optical instruments), R and J Beck, Ltd (optical instruments), Bellingham and Stanley, Ltd. (optical instruments), W Butcher and Sons, Ltd (the optiscope projection apparatus and the autoprint photographic enlarger), the Cambridge Instrument Co., Ltd. (thermometric and various precision instruments), the Cambridge University Press, Carbic, Ltd. (the Otis King's calculator), the Chromoscope Co., Ltd (the mutochrome, for varying the colours in patterns and designs), Cooke, Troughton and Simms, Ltd. (surveying instruments), A C Cossor, Ltd. (thermionic valves), Creed and Co., Ltd. (printing telegraphs), Crompton and Co., Ltd. (electric laboratory apparatus), George Culver, Ltd. (opticians' goods), J. H. Dallmeyer, Ltd. (cameras and lenses), the Damard Lacquer Co., Ltd. ("Formite" bakelite synthetic resin products for insulation, etc., the hardness of which is suggested by a humorist to have given rise to the company's name), Darmont Electric Batteries, Ltd, F. Davidson and Co. (optical instruments), the Dubilier Condenser Co. (1921), Ltd. (impedances), Edison Swan Electric Co., Ltd (pointolite lamps), W. Edwards and Co., Ltd. (vacuum pumps), Elliott Bros (London), Ltd (electrical testing apparatus), Everett, Edgecumbe and Co., Ltd (electric testing apparatus), Evershed and Vignoles, Ltd. (electric tests, wireless, traction recorder for electric trains), Foster Instrument Co. (pyrometers), E. B. Fry, Ltd. (time measuring and lantern slides), A. Gallenkamp and Co., Ltd. (electric furnaces, etc), Gambrell Bros, Ltd (electric testing), F. Harrison Glew (radio-active apparatus and cobalt steel magnets), John J Griffin and Sons, Ltd. (potentiometers, etc), W H. Harling (drawing instruments), Adam Hilger, Ltd. (optical and spectrographic instruments), Henry Hughes and Son, Ltd. (compasses, range-finder, etc), Igranic Electric Co, Ltd (wireless parts), the India Rubber, Gutta Percha and Telegraph Works Co., Ltd. (telegraph apparatus), Geo. Kent, Ltd (air, gas and steam meters), Kodak, Ltd. (cameras, etc), H K, Lewis and Co, Ltd. (scientific publications), Macmillan and Co, Ltd (scientific publications), Marconi's Wireless Telegraph Co, Ltd., the M O Valve Co., Ltd (wireless valves), the Mullard Radio Valve Co., Ltd (Holweck molecular pump and valves), Nalder Bros and Thompson, Ltd. (electric testing instruments, etc), Negretti and Zambra (meteorological instruments), Newton and Co (optical projectors), L. Oertling, Ltd (balances and the Eötvös torsion balance), Ogilvy and Co (microscopes and accessories), W. Ottway and Co., Ltd (surveying instruments, etc), Record Electrical Co, Ltd (switchboard apparatus), Ross, Ltd. (optical and photographic instruments), Short and Mason, Ltd. (meteorological instruments), Siemens Bros and Co., Ltd. (electric thermometry), H W. Sullivan, Ltd. (high frequency, cable and other electric testing apparatus), J. Swift and Son, Ltd. (industrial microscopes, etc), H. Tinsley and Co (electric testing, etc., apparatus), Watson and Sons (Electro-Medical), Ltd (X-ray apparatus), W. Watson and Sons, Ltd (optical instruments), Weston Electrical Instrument Co, Ltd. (electric testing apparatus), Wireless Press, Ltd., *The Wireless World and Radio Review*, Wray (Optical Works), Ltd. (cameras, lenses, and the nephelometer for measuring opalescence), Zenith Manufacturing Co. (resistances, etc.).

Annual Meeting of the Science Masters' Association.

THE twenty-fifth annual meeting of the Science Masters' Association was held on January 5, 6, and 7 at the University of Leeds, at the kind invitation of the University authorities Members were housed at the University Hostels, an act of hospitality which was very much appreciated The fact that the meeting was held at Leeds gave those members residing in Scotland and the North of England an excellent opportunity of attending, and the number present was very large The meeting began with a dinner in the Refectory, at which the Association was entertained by the University Afterwards there was a reception in the Great Hall by the Vice-Chancellor, Dr J. B Baillie, and the President of the Association, Sir Berkeley Moynihan, Bart, professor of clinical surgery in the University.

After a delightful speech of welcome by the Vice-Chancellor, which was suitably acknowledged by the chairman of the Association, Mr E. A Gardiner (Louth Grammar School), Sir Berkeley Moynihan delivered his presidential address The subject he chose was the debt which science owes to medicine, and was introduced by an historical survey of the progress of medicine from the earliest days to the present time. Claiming that Hippocrates and Galen were the inventors of the inductive and deductive methods respectively in science, the president passed in rapid review the events of succeeding centuries and astonished his audience by showing how many eminent men of science had been physicians or surgeons. Although, for several centuries, the growth of medicine scarcely kept pace with that of the slowest

of her intellectual children, the establishment of pathological anatomy at the hands of John Hunter and others, and, in more recent times, the great work of Lister, finally resulted in the reunion of the two methods of scientific inquiry—observation and experiment—so long divorced in medicine

After referring to the great difficulty in medicine of obtaining an accurate anamnesis, the president expressed his views on the nature of the help which might be expected from researches carried out in the laboratory .He pointed out that discovery of the cause of a disease, though often extremely valuable, does not necessarily mean that we can immediately effect a cure, or even that we should be able to devise a more efficacious method of treatment Treatment of tuberculosis, for example, has been very little changed by the discovery and isolation of the tubercle bacillus In the same way, even if science solves the problem of the cause of cancer, it does not follow that that fell disease will at once become curable. So far as cancer is concerned, indeed, Sir Berkeley said that we should never forget that we already know how to cure it in almost all parts of the body in which it commonly occurs Nothing in clinical practice is more certain than this—that cancer in the first instance is a local disease, and that, with few exceptions, an early operation for any cancerous growth is attended by only the slightest risk, if indeed by any, and may confidently be expected to confer a permanent immunity from a return of the disease

The chairman then called upon Prof. A Smithells, past president of the Association, to move the vote of thanks. Prof Smithells referred feelingly to the warm friendship which had existed for so long between the president and himself, and expressed the thanks of the Association in very happily chosen words The vote was seconded by Prof H E Armstrong, who has been a staunch friend of the Association, no less than its tireless mentor, since its inception a quarter of a century ago. The audience showed its appreciation of Sir Berkeley's address by carrying the vote with enthusiasm.

Tuesday morning was devoted to the business meeting, and to lectures given to the Association by Profs. J. H. Priestley, R Whiddington, and R W. Whytlaw-Gray. During the afternoon and evening, demonstrations were given in the laboratories by members of the University staff, and tours were made through the Departments of Textile Industries, Leather Industries, Colour Chemistry, and Engineering. Members of the Association expressed great pleasure at the laboratory demonstrations, where they obtained many new ideas for their own courses at school. Special mention must be accorded to the delightfully simple apparatus devised for showing the Brownian movement in tobacco smoke, which attracted a great deal of attention and requires nothing more elaborate than two good microscope objectives and a suitable source of light

On Wednesday there was a fruitful discussion on the connexion between science teaching in schools and universities, in which both sides were well represented The discussion was opened by Prof Smithells, who was followed by Dr Terry Thomas (Head Master of Leeds Grammar School), Mr F S Young, Mr Willings, Mr F B Stead (H M I), Prof W. P Milne (University of Leeds), and others In the afternoon, excursions were made to the Leeds Forge, the Yorkshire Copper Works, the Yorkshire Iron and Coal Co , Ltd., the West Ardsley Collieries, Messrs Ackroyd and Best (glass-blowing), the Prospect Mills (spinning, weaving, dyeing, and finishing), and Messrs J Nicholson and Sons, Ltd (sulphuric acid works) The educational importance of these visits, which enabled members to realise more closely the relationship between science and industry, can scarcely be exaggerated, and thanks were expressed to the various firms for their kindness in receiving the Association.

During the whole of the meeting there were excellent exhibitions of books, chemicals, and scientific apparatus by the leading firms, among which the exhibit by the local house of Reynolds and Branson may be specially noted There was also a stall devoted to books written by members of the Association, which testified to their literary activity A noteworthy feature was a list of books suitable for school science libraries, which should prove of great value to those engaged in teaching science in schools

It was announced that the Bishop of Birmingham had been asked, and had agreed, to act as president for the coming year

The meeting was one of the most successful in the history of the Association, and warm thanks were conveyed to the Vice-Chancellor and all other members of the University who had done so much to make the visit a memorable one Congratulations were also offered to the University on its recent jubilee celebrations.

Automatic Telephony and Teletyping.[1]

IT may be doubted whether the present generation works harder than the last, but, at any rate, it works at a much higher speed, and all kinds of devices are used to accelerate its rate of working. Whether this movement is altogether for the ultimate benefit of the human race is a moot question, but that it exists every one knows who has had experience of modern business methods. The incentive is the increase of profits that comes from doing an increased volume of work in a given time, by the aid of machinery. Speed and haste have very different meanings, and if the quality of the work does not suffer by the higher rate at which it is done, then the increase is beneficial, especially when it increases the time of the worker for exercise and recreation.

Amongst the devices for speeding up business, automatic telephony and printing telegraphy, or teletyping, will play a prominent part in the future. It is perhaps not generally known that the work of converting the manually operated telephone system of London into an automatic switching system has already been started The task is a stupendous one, and it will take fifteen years to complete

The accuracy of the service given in any telephone exchange, whether manual or automatic, depends largely on the ability of subscribers to use the telephone properly The delays that occur at present are often due to a lack of clearness in articulating both the name of the exchange and the number, and to the congestion of traffic during the "busy hour" In an automatic, or, as the Americans more properly call it, a machine switching exchange, these difficulties do not arise, and if we make the probable assumption that a well-looked-after machine is more accurate than a human being, it seems certain that the machine switching system will give a better service than the manually operated system we have at present.

During the progress of conversion a called subscriber will often be connected with a manually operated exchange. The calling subscriber operates his instrument in the usual way, and the call passes to an operator at the manual exchange. Fitted to the panel in front of this operator is a group of forty lamps divided into four sections of ten lamps each,

[1] From the Presidential Address to the Junior Institution of Engineers, delivered by Dr. Alexander Russell on Wednesday, January 7.

and each section is numbered from 1 to 10. When the number dialled by the calling subscriber is received by this apparatus, four lamps glow, one in each section, and the operator sees at a glance the number of the subscriber required The calling subscriber does not speak, and the connexion is made with the same ease as if it were all automatic

When two subscribers attempt to call another at the same time, one gets through and the other hears the engaged signal But when a call is made through a manual exchange, and the operator finds the required line is engaged, the call is stored until the line is clear

One great advantage of the machine switching system is that the service will be as good in the night time as during the day. Except for, possibly, one or two short periods at the rush hours, the highest grade of service will be given Errors due to faulty articulation will be a thing of the past It has to be remembered that the system adopted by the British Post Office is one that is capable of being continually improved Although the mechanisms remain the same, the rapid expansion of the system may lead to changes in the methods of operation in the immediate future.

These great auto-exchanges, with thousands of movable contacts in continual operation, appear uncanny to the non-technical person, but telephone engineers regard them in the same way as we would look on a large indicator for electric bells Seeing that there are now more than twenty million telephone exchange stations in the world, it is instructive to remember that the first was built less than fifty years ago We can be quite certain that the next fifty years will show an equally marvellous progress

Wonderful though automatic telephony is, electricians believe that in a few years' time it will have an equally wonderful rival in the new printing telegraphy The " ticker " is well known in large business offices where the latest quotations are printed in a continuous stream on a strip of paper The latest information is thus always available and can be acted on immediately. In the United States both the Western Union and the Bell Telephone Companies will shortly offer telegraph typewriter service to business men, and it seems highly probable that this will be a commercial success It will lead to teletype telegraphy, in which automatic switching exchanges not unlike those used in automatic telephony are employed.

It is perfectly feasible with this system for an ordinary girl typist to send messages up to 5000 miles at a speed of at least 30 words a minute. The British Post Office has already teletypes in use on several long lines As the method extends, machine switching stations will become a necessity and are certain to be employed It looks as if, in a few years' time, every wealthy person will have a " ticker " line for news superposed on his telephone line, his radio set being reserved mainly for entertainment purposes.

At first sight it might be thought that an air mail service would be a great rival to teletype telegraphy, but this is not the case The actual time of a letter by air mail to Paris is about four hours. It takes about 40 minutes to get from Charing Cross to Croydon Aerodrome. From Croydon to the Paris Aerodrome takes about 2½ hours, and from the aerodrome in Paris to the city another 30 minutes Finally, we have to allow at least 20 minutes for posting and delivery. It would generally, therefore, take more than four hours By the new telegraphy a long printed telegram could be received in 10 minutes. For distances greater than 50 miles the new printing telegraphy would probably be better than telephony.

A serious drawback to the use at present of teletyping is the cost of a cheap printer and of a trustworthy typewriter keyboard, but in a few years' time, it is possible that there may be such a demand for hundreds of thousands of them as would make them very considerably cheaper; they might then cost little more than an ordinary good quality typewriter. There would be a local rate for payment and, doubtless, also a time and distance rate.

University and Educational Intelligence.

LONDON.—A number of free public lectures have been arranged for the coming term. Among them are the following, the number of lectures in the case of a course being indicated in brackets, and the lecture hour being 5 30 unless otherwise stated :—

At University College.—Series of eight lectures beginning on January 27 : Prof G. Elliot Smith, on the evolution of man; Mr. W. J. Perry, on the beginnings of civilisation, and on the spread of culture; Dr C F Sonntag, on man's place in Nature (2); Prof. J. E. G. de Montmorency, on the significance of the humanism of the negro races; Mr. Reginald A. Smith, on the Old Stone Age, and Mr. C D. Forde, on the megalithic monuments of Brittany; Dr A. S Parkes, on the physiology of reproduction (6), beginning January 22 at 5 P.M, Prof. A. V. Hill, on the physiology of muscle and nerve (12), beginning January 23, at 11 A.M.; Prof. T B. Wood, on the nutrition of the young animal (3), beginning March 4; Prof. A C. Seward, on a botanical topic (3), commencing March 17, Prof H Westergaard, University of Copenhagen, on vital statistics (2), commencing March 9; Mr. A. Gomme, on technical and scientific libraries, on February 18 (one of a series of five lectures on the use of libraries).

At King's College—Dr. J. A. Hewitt, on carbohydrate metabolism (8), beginning January 19 at 5 P.M; Prof. E V. Appleton, on the rôle of the atmosphere in wireless telegraphy, on January 19; Mr C J. Gadd, on the excavations at Ur, on January 26; Mr. S. Smith, on the nature and influence of Babylonian literature, on February 9, series of three lectures on Chinese civilisation: Lieut.-Commdr. A S. Elwell Sutton, general views (February 5); Prof W. E. Soothill, China's contribution to Western civilisation (February 12); Dr. I. P. Bruce, education in China (February 19); Prof. A. E. Jolliffe, on English mathematics before Newton, on February 16; Prof. E Prestage, on Vasco Da Gama and the discovery of the sea-route to India, on February 13; Prof E. W. Scripture, experimental investigations of German poetry, on February 26.

At the Royal School of Mines, S. Kensington.—Prof. L Denoël, University of Liège, on tubbing deep shafts and subsidence (4), beginning February 23; Prof. C. A. Edwards, on chemical combination in metallic alloys and its nature (4), beginning March 3.

St. Bartholomew's Hospital Medical College.—Prof. C. Lovatt Evans, on the physiology of plain muscle (4), which began on January 14.

APPLICATIONS are invited for the professorship of botany in the West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, in succession to the late Prof. A. N. McAlpine. The latest date for the receipt of applications is February 15.

ADULT education has been provided for in the United States on a rapidly increasing scale since the War. This is due to several causes, one being anxiety on the part of the State universities to give through their extension divisions conspicuous evidence of their usefulness, another the emergence of an insistent demand " that those who live in America must understand America." In Bulletins, 1923, Nos. 30 and 31, of the United States Bureau of Education, detailed accounts

are given of measures recently taken for the Americanisation of adult immigrants, especially in California. It had become apparent that the very efficiency of the education given to their children in the common schools was undermining the control of the immigrant parents and disrupting their family life. "Under the roof of every immigrant home is going on a death struggle between two worlds, two cultures, two civilizations,—in the same family circle different tongues are spoken, different newspapers and books are read, different manners and customs observed, . . . a delicate network of precious traditions is (so it seems to the immigrant) being ruthlessly torn asunder, a whole world of ideals is crashing to ruin, and amid this desolation the father and mother picture themselves wandering about lonely in vain search of their lost children." To meet this situation, the State of California has provided for the employment of "home teachers" to work in the homes of the pupils of the common schools, giving instruction in sanitation, the English language, home economics, and the fundamental principles of the American system of government and the rights and duties of citizenship. It is clear from the report that these teachers, where carefully chosen, are doing extremely valuable work—such work, moreover, as is perhaps needed quite as much in other countries, including Great Britain, where aliens are numerous.

THERE is a marked contrast in the system of government, *i.e.* in the localisation of administrative power, between the universities of Australia and those of Great Britain and the United States. In the United States, the president, and in the British Isles the vice-chancellor (or principal), is the controlling and unifying force. The constitution of the University of Sydney provides that the Senate of 24 members, of whom not necessarily more than 5 need be members of the teaching staff, has the entire management of and superintendence over its affairs. It has hitherto out of its own body, annually, elected a chancellor and a vice-chancellor, the latter usually being a lawyer. Melbourne is governed by a Council of not more than 31 members, of whom less than one-third can be and less than one-quarter must be members of the teaching staff. The Professorial Board may forward to Council an opinion on any matter relating to the University, as may also Convocation, which consists of all graduates, but neither the Professorial Board nor Convocation has executive functions. The Council elects, annually, a chancellor and a vice-chancellor. For some time past the teaching members of the Australian universities have felt the need of a permanent chief. Sydney had already taken a step in that direction by appointing a warden when the Conference of Australian Universities in 1920 adopted the following resolution in favour of the establishment of an executive office analogous to that of principal or vice-chancellor of a British university:—"That it is desirable, for more effective working and consonant with the general character of Australian Universities, that the appointment of an officer of high status, who could adequately represent both the administrative and the educational aspects of the University before other Universities and the public generally be seriously considered." The Senate of Sydney has recently given effect to this resolution by converting the vice-chancellorship into a stipendiary administrative office. To this office, Dr. M. W. MacCallum professor of modern literature for the period 1887–1920 and since 1920 emeritus professor, has been appointed as the first incumbent. Dr. MacCallum will shortly arrive in England for the purpose of delivering lectures by invitation of the British Academy.

Early Science at the Royal Society.

January 17, 1677/8. Dr. King instanced, that a gentleman who was a patient of his, could, two or three miles off London, discover when he entered into the smoke of London. Upon this some discourse arose about the reason why some chimnies smoke, that is, do not convey the smoke from the fire up the funnel, but suffer it to spread into the room.

January 18, 1664/5. Sir Robert Moray produced a discourse concerning coffee, written by Dr. Goddard at the King's command. Mr. Boyle mentioned, that he had been informed that the much drinking of coffee produced the palsy. The Bishop of Exeter seconded him. Mr Graunt affirmed that he knew two gentlemen, great drinkers of coffee, very paralytical. Dr Whistler suggested that it might be inquired whether the same persons took much tobacco.

1671/2. Mr Newton's new telescope was examined and applauded.

January 20, 1663/4. The general and particular warrant to demand bodies for dissection, drawn up by Sir Anthony Morgan, was read and approved. [The president afterwards stated that a warrant had been issued for demanding a body for dissection, which was to be performed the day after the execution, in Gresham College, by Dr Charleton, who had offered himself to open the muscles after a new method.]

1669/70. Mr Hooke produced for examination two ways of making an universal measure. Many exceptions were made by divers members against both these ways. For these and like difficulties both these ways were laid aside.

January 21, 1662/3. Dr Merret acquainted the society that he had received an information from Naples, concerning a person, who had an art of keeping new-born infants alive without respiration, for a good while. It was thought very desirable to have farther inquiry made.

1674/5. Sir John Bankes made a full report concerning the three fee-farm rents payable from fewes; concerning which the council accepted of the proposal, and resolved to dispose of the four hundred pounds legacy of the late Dr Wilkins, bishop of Chester, for purchasing of them, and accordingly desired Mr. Hoskyns to take care of a legal conveyance of the same to the Royal Society and their successors. —Mr. Oldenburg mentioned, that the earl of Aylesbury being obliged to go out of town, could not take care of providing a lecture, as he thought to have done, and had therefore sent to him his forty shillings; which money was delivered to the treasurer.

January 22, 1661/2. The experiment of making marbled paper was made by a man introduced by the amanuensis; which succeeded according to Mr. Evelyn's description of that method.—The pendulum experiment was discoursed of by the lord viscount Brouncker, who brought in the account and schemes of it. His lordship's paper was ordered to be registered, and a copy of it made against the Friday following, and brought to Sir Robert Moray, to be sent to Mons. Huygens.

1673/4. Mr. Lister having formerly sent some of his blood-stanching liquor, with a desire, that trials might be made with it before the Society, it was ordered, that the operator should provide a dog against the next meeting for that purpose.

January 23, 1666/7. Mr. Hooke was ordered to bring in something in writing relating to the controversy between Mr. Hevelius and Mons. Auzout, which might impart, that upon examination of the observations made in England, and compared with those in other parts, the society was inclined to believe, that Mr. Hevelius had been mistaken.

Societies and Academies.

LONDON

Linnean Society, December 18.—E. J. **Collins**: The physiological aspect of the incidence of late blight (*Phytophthora infestans*) of potatoes. So far as the foliage is concerned, that of the early varieties of potato and those most susceptible to blight have the highest water content, the most resistant, which are the latest to mature, have the lowest water content. High water content induces rapid tuberisation, and this entails early maturation and susceptibility to blight. The nitrogen content of the foliage reaches a maximum and then falls more or less rapidly according to the growth period of the variety. Maturation is thus accompanied by a decreasing nitrogen content of the foliage. The water : nitrogen ratio increases during the season and in general is highest at the time of infection. The degree of susceptibility to blight is indicated more precisely by the value of this ratio. Young foliage has a lower water and higher nitrogen content than foliage of a medium age, while in old foliage the reverse conditions hold. Sprayed foliage shows a lower water and a higher nitrogen content than unsprayed foliage. The value of spraying, apart from the action of the copper solution as a fungicide, lies in its physiological effect, since those metabolic changes accompanying old age, and heightening susceptibility, are delayed.—R. B. **Seymour Sewell**: A study of the Andaman sea-basin. The Andaman Sea appears, originally, to have been formed during the Eocene epoch as a comparatively shallow brackish-water estuary, into which all the main rivers of Burma flowed, by the simultaneous upheaval of parallel mountain-ranges. At the close of the Miocene period a second upheaval, volcanic in character, caused the appearance of a mountain-chain that is now represented by Narcondam Island, Barren Island, and Invisible Bank. The present deep basin is due to extensive subsidence, probably in post-Tertiary times. Continued subsidence, or subaerial erosion followed by a rise of sea-level led to the formation of various channels permitting the entry into the basin of a shallow-water fauna derived from both the Indian and Pacific Oceans, and of a deep-water fauna derived from the Bay of Bengal.

PARIS.

Academy of Sciences, December 8.—Paul Séjourné was elected a free academician in succession to the late Prince Bonaparte.—Pierre **Humbert**. The $V_{m,n}$ functions of Hermite with imaginary indices.—A. **Kovanko**: Suites of functions of class I (Baire).—Stanislas **Millot**: Some problems of Laplace. A discussion of some problems in the theory of probability.—E. **Paloque**: A new instrument for the determination of time and of latitude. This instrument is based on the observation of the simultaneous passage of two stars in the same azimuth.—Jean **Chazy**: The arrival in the solar system of a foreign star.—Charles **Henry**: A formula of the theory of relativity.—Jean **Granier**. The absorption of electromagnetic waves by ice. For the temperatures and frequencies studied, a condenser of pure ice may be represented by an arrangement of two condensers in parallel, one with an inductive capacity equal to 2·05, the other with an inductive capacity of about 78, the latter being in series with a resistance the value of which decreases as the temperature increases.—Félix-Joachim de **Wisniewski**: The doublets of the alkali metals.—P. **Job**: The electrometric study of hydrolysis.—A. **Boutaric** and G. **Corbet**: The critical temperature of solution of ternary mixtures. Curves are given showing the relation between critical solution temperatures of various ternary mixtures and their composition.—Jean **Thibaud**: The penetrating γ-radiation of mesothorium-2.—L. J. **Simon** and A. J. A. **Guillaumin**. Some derivatives of tetracetylmucic acid.—Léon **Piaux**. The spontaneous oxidation in alkaline solution of 1-methyluric and 1·3-methyluric acids. On oxidation in alkaline solution, 1-methyluric acid behaves similarly to uric acid, but 1·3-dimethyluric acid is completely split up, giving methylamine, potassium oxalurate and oxalate.—Georges **Patart**: The synthesis of methyl alcohol by reduction of carbon monoxide. A mixture of carbon monoxide (1 vol.) and hydrogen (1·5 to 2 vol.), under a pressure of 156 to 250 atmospheres, is circulated over a catalyst (zinc oxide) at a temperature between 400° and 420° C. On cooling to 20° C., a liquid is obtained containing water and methyl alcohol, with traces of impurities. Neither aldehyde nor acetone is present in this alcohol. The author considers that the commercial preparation of synthetic methyl alcohol by this method offers no serious difficulties.—Henri **Hubert**: Contribution to the study of the microseismic disturbances at Dakar (Senegal). The small earth vibrations at Dakar would appear to be mainly due to the impact of waves of the sea at points near this locality.—Ch. **Maurain**: The propagation of aerial waves as shown by the experiments at La Courtine. Two maps are given showing areas in which the velocity of propagation of the waves was that of the velocity of sound, and other areas in which the velocity was much lower than the velocity of sound; the latter are called zones of abnormal reception.—E. **Delcambre**: The meteorological work of the Jacques-Cartier service.—Ch. **Kilian** and R. G. **Werner**: Pure cultures of the fungi of lichens.—Mme L. **Randoin**, J. **Alquier**, Mlles **Asselin** and **Charles**: The nitrogenous materials of wheat offal. Comparative study of their biological value as factors of upkeep, of growth and of reproduction. Wheat offals (bran, etc.) regarded as a source of nitrogen have not the same biological value in a normal ration.—M. and Mme G. **Villedieu**: The action of solutions of copper sulphate on mildew. Millardet in 1886 pointed out the toxic action of very dilute solutions (1 in 4,000,000) of copper sulphate on the mildew of the vine (*Plasmopara viticola*). The authors show that the copper sulphate was not really in solution, but was present as very fine flocculated precipitates of basic copper sulphate, removable by filtration. The toxic action is exerted by this insoluble basic copper sulphate.—A. **Malaquin**: The genital glands and primordial sexual cells in the annelid *Salmacina Dysteri*.—J. **Legendre**: Zoophilia in mosquitoes and its application to prophylaxy.—A. **Paillot**. A new disease of the caterpillars of *Pieris Brassicae*, and on diseases of the nucleus (of the blood corpuscles) in insects.—Ch. **Dhéré**, A. **Schneider** and Th. van der **Bom**: The fluorescence of some metallic compounds of hæmatoporphyrin. Details of the photographed fluorescence spectra of the compounds of hæmatoporphyrin with zinc, tin, lead and cadmium.—Albert **Dalcq**. A new method of experimental parthenogenesis and its application. The maturation, activation and segmentation of the egg of *Asterias glacialis* can be produced by a single solution: the segmentation of the virgin egg is the result of the specific effects of various cations.—C. **Dawydoff**. Réduction in *Limeus lacteus*.

CALCUTTA.

Asiatic Society of Bengal, November 5.—S. H. **Lele**: Studies on Bombay fish. Revision of the genus Drepane (Cuv. and Val.). The anatomical

and morphological characters of the members of the genus Drepane are discussed. In view of constant differences, the genus should be split up into two species, as was done by Cuvier and Valencinnes.—B P **Uvarow**: Orthoptera (except Blattidæ) collected by Prof. Gregory's expedition to Yunnan. An account is given of the Yunnanese crickets and their allies collected by Prof. Gregory. The fauna of the Yunnanese mountains is found to be palæarctic while that of the valleys is truly oriental.—R. **Hanitsch**. Blattidæ collected by Prof. Gregory's expedition to Yunnan. Three species were found in Prof. Gregory's collection, two of which are described as new to science.—H **Hosten**: (1) Zādoē, of St. Thomas' Monastery in India (about A.D 363). A short supplementary note to the author's recent study on St Thomas and San Thomé, Mylapore, in the Society's Journal, quoting a reference to St Thomas purporting to go back to the fourth century A.D. (2) A letter of Fr. A de Andrada, S.J. (Tibet, August 29, 1627), and of Fr. Gaspar Diaz, S.J. (Annam, 1627). Spanish texts, with English translations, and notes. The letter by Diaz was published together with the other, probably in 1629, in two folio leaves, and a copy of the publication is in the British Museum. De Andrada's letter is not known in its original Portuguese form. Both give additional data concerning early European contact with Tibet and Further India. (3) A letter of Father Francisco Godinho, S.J., from Western Tibet (Tsaparang, August 16, 1626). This original French text adds to the data recently made available concerning early contact with Tibet through the efforts of the Roman Catholic missionaries in the beginning of the seventeenth century.—A S **Ramanatha Ayyar**. A note on Arddhanārīśvara. The identification proposed by Father H Hosten in his recent paper on St. Thomas in the Society's Journal is criticised. The figure there interpreted as the representation of an Amazon is in reality one of Arddhanārīśvara. The theory of Egyptian influence at Mahābalipuram in the seventh century A.D. is therefore rejected.—M Hidayet **Hosain**. The development of the Hadīth concordance in Arabic literature. The traditional sayings attributed to the Prophet Muhammad form a body of literature ranking first in importance in Islamic theology after the study of the Quran itself. The number of these sayings is overwhelmingly great, and from early times Muslim theologians have felt the need for the classification of them, and for a system to refer them to their sources. The science of "locating" the traditions is called "'Ilm al-Atrāf," and the author traces the development of the literature expounding this science from A.H. 400 to the present day.—'Abdul **Wali**. Sketch of the life of Sarmad Sa'id, surnamed Sarmad, a contemporary of Shah Jahan and Aurangzeb, was a Persian of Jewish birth. He came to India and after much wandering settled at Delhi. He was of a mystic temperament and embraced Islam, into which he introduced his mystic speculations. On a charge of heresy he was beheaded by order of Aurangzeb.

Official Publications Received.

Proceedings of the Eleventh Indian Science Congress (Bangalore, 1924). Pp. xv+262. (Calcutta: Asiatic Society of Bengal.) 6 12 rupees.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 12, Part 2. Über den Einfluss meteorologischer Faktoren auf den Baumzuwachs (I). Über den Einfluss auf den Stammumfang eines Tannenbaumes. Von Hirokichi Nakashima. Pp. 69-263+plates 18-26. (Sapporo.)

Public Health Administration and the Natural History of Disease in Baltimore, Maryland, 1797-1920. By Dr. William Travis Howard, Jr. (Publication No. 351.) Pp. vi+565+2 maps. (Washington: Carnegie Institution.) 5.25 dollars.

General and Physiological Features of the Vegetation of the more Arid Portions of Southern Africa, with Notes on Climatic Environment. By William Austin Cannon. (Publication No. 354.) Pp. viii+159+31 plates. (Washington: Carnegie Institution.) 2 50 dollars.

Root Behavior and Crop Yield under Irrigation. By Frank C. Jean and John E. Weaver. (Publication No. 357.) Pp. v+66+6 plates. (Washington: Carnegie Institution.) 1 25 dollars.

Department of Agriculture, Straits Settlements and Federated Malay States. Bulletin No. 36. "Red Stripe" Weevil of Coconuts (*Rhynchophorus schach*, Oliv.). By G. H. Corbett and D. Ponniah. Pp. 51+6 plates. (Kuala Lumpur.) 50 cents.

Department of Commerce. U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No. 208. Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1923. By Daniel L. Hazard. (Special Publication No. 102.) Pp. 44. (Washington: Government Printing Office.) 10 cents.

Proceedings of the Royal Society of Edinburgh, Session 1924–1925. Vol. 45, Part 1, No. 2. The Irreducible System of Concomitants of Two Double Binary (2,1) Forms. By W. Saddler. Pp. 3-13. Vol. 45, Part 1, No. 3. A Series Formula for the Roots of Algebraic and Transcendental Equations. By A. C. Aitken. Pp. 14-22. Vol. 45, Part 1, No. 4. The Electrolysis of Salts of Alkyloxyacids. By Dr. David A. Fairweather. Pp. 23-33. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 1s. each.

Anuario del Observatorio de Madrid para 1925. Pp. 477. (Madrid: Instituto Geográfico.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 17, N.S., Nos. 42-47, August. 42. Experiments on the possible Effect of Vitamins on Quantity of Milk and Butter Fat, by E. J. Sheehy. 43. A Mechanical Device for Sealing off Radium Emanation Tubes, by Dr. H. H. Poole; 44: Notes on the Filtration and other Errors in the Determination of the Hydrogen Ion Concentration of Soils, by Dr. W. R. G. Atkins. 45. Variations in the Permeability of Leaf Cells, by Prof. Henry H. Dixon; 46. Notes on Acarine or Isle of Wight Bee Disease, by Lt.-Col. C. Samman and Prof. J. Bronte Gatenby. 47. Note on a Physical Method of separating the Fats in Butter-fat, by Prof. Felix E. Hackett and T. A. Crowley. Pp. 333-368. 4s. Vol. 18, N.S., Nos. 1-4, November 1. Seasonal Changes in the Water and Heleoplankton of Fresh-water Ponds, by W. R. G. Atkins and G. T. Harris. 2. The Synthesis of Urea from Carbon Dioxide and Ammonia under Atmospheric Pressure (Part 1), by Dr. Kenneth C. Bailey; 3. Oogenesis in Lithobius forficatus, by S. D. King. 4. The Determination of the most Economic Size of Pipe line for Water power Installations, by H. H. Jeffcott. Pp. 48. 5s. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.)

Department of Commerce. Bureau of Standards. Miscellaneous Publications No. 58. Technical Conference of State Utility Commission Engineers, held at the Bureau of Standards, Washington, D.C., March 2 and 3, 1923. Pp. iii+80. (Washington: Government Printing Office.) 15 cents.

National Museum of Wales. Seventeenth Annual Report, 1923-24, presented by the Council to the Court of Governors on the 24th October 1924. Pp. 38+6 plates. (Cardiff.)

City of Leicester Museum and Art Gallery. Twentieth Report to the City Council, 1st April 1912 to 31st March 1924. Pp. 66. (Leicester.)

The National University of Ireland. Calendar for the Year 1924. Pp. viii+824+369+117. (Dublin.)

Annuaire pour l'an 1925, publié par le Bureau des Longitudes. Pp. viii+680+A71+B30+C71. (Paris: Gauthier-Villars et Cie.) 6 50 francs.

The Pleistocene of the Middle Region of North America and its Vertebrated Animals. By Oliver P. Hay. (Publication 322A.) Pp. vii+385. (Washington: Carnegie Institution.) 2 50 dollars.

City and County of Bristol. The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee, for the Year ending 30th September 1924. Pp. 20+8 plates. (Bristol.)

Ministry of the Interior, Egypt. Department of Public Health. Reports and Notes of the Public Health Laboratories, Cairo. Ankylostomiasis and Bilharziasis, Cairo. Pp. iii+196. (Cairo: Government Publications Office.) 30 P T.

Diary of Societies.

SATURDAY, JANUARY 17.

PHYSIOLOGICAL SOCIETY (in Physiological Laboratory, St. Thomas's Hospital), at 4.—R. J. S. McDowall: The Sensory Sympathetic Nerves.—J. W. Pickering and H. Gordon Reeves: Thrombocytes and Blood Coagulation.—K. Furusawa: The Respiratory Quotient of the Excess Metabolism produced by Muscular Work.—A. St. G. Huggett and Prof. J. Mellanby: Preparation and Properties of Secretin.—L. N. Katz: The Asynchronism of the Contraction of the two Ventricles.—E. C. Smith: Insulin and Fat Metabolism.—R. Kinosita: Effect of Breathing against a Resistance.—J. Needham and Dorothy Needham: The pH and rH of the Cell-Interior—a Micro-Injection Study.—D. Burns: (1) The Inter-relation of the Parathyroids and the Gonads, (2) Guanidine in Urine.—Sybil Cooper: The Rate of Conduction in Nerve in the Supernormal Phase of Recovery.—C. D. Murray and H. Taylor: Method of Determination of the Oxygen and CO_2 in Mixed Venous Blood.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Manchester College of Technology), at 7.—J. G. Robinson: Moulding a large Fly-Wheel (Lecture).

MONDAY, JANUARY 19.

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. Dorothy M. Wrinch: Seismic Phenomena.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—C. S. Wright: The Origin and Movements of the Ross Barrier.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (I). The Antiquity of Man in South Africa. The Boskop Skull. The Relationship of the Boskop Race to Bushmen and Hottentot.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—A. J. D. Humby: Turbo-Blowers.

JUNIOR INSTITUTION OF ENGINEERS (North Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—J. Prior. Confectionery Machinery.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—C. Macbeth. Low-Pressure Pneumatic Tyres.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30.—Sir Oliver Lodge (Lecture).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. O. Faber: Applications in Building and Foundations of Modern Engineering Construction.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—W. O. Brigstocke: Pickwickian Senses.

ROYAL SOCIETY OF ARTS, at 8.—V. E. Pullen: Radiological Research.—a History (I). (Cantor Lectures.)

TUESDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. Fowler: The Analysis of Spectra (II.).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Miss K. Yardley: An X-ray Examination of Calcium Formate.—J. Parry and Dr. F. E. Wright: Afwillite, a New Hydrous Calcium Silicate from Dutoitspan Mine, Kimberley, South Africa.—Prof. P. N. Chirvinsky: On Tyuyamunite from Tyuyu Muyun Radium Mine, Fergana.—Dr. L. J. Spencer: International Agreement in Mineralogical and Crystallographical Nomenclature.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Eng.-Lt. A. Marsden: Oil Fuel Burning in Steam Generator and Furnace.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub Centre) (at Derby Technical College), at 6.45.—C. Beaver: Some Points in the Manufacture and Installation of High-Voltage Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—H. W. Taylor: Three-Wire Direct-Current Distribution Networks.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—Kinematograph Demonstration of some Experiments in Physics.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineers' Club, Wolverhampton), at 7.30.—C. Macbeth: Low-Pressure Pneumatic Tyres.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (Informal Meeting) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Miss Kennedy: Electric Cooking.

MEDICO-LEGAL SOCIETY (at 11 Chandos Street, W.), at 8.30.—F. Ll. Jones: The Laws of Nations and the Health of Nations.

WEDNESDAY, JANUARY 21.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (II.). The Rhodesian Skull. The Relationship of Rhodesian Man to Living and Extinct Types of Mankind.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. Léon W. Collet: Recent Views on Alpine Tectonics.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—Sir Oliver Lodge: Matter and Radiation (Presidential Address).

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates Meeting) (at Chamber of Commerce, Birmingham), at 7.30.—J. G. Sheriff: Steering.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—W. E. Burnand: Inventions and Patents.

INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.30.—H. A. Randall: Instruments and Gauges.

ROYAL METEOROLOGICAL SOCIETY (Annual General Meeting), at 7.40.—C. J. P. Cave: The Present Position of Meteorology and Meteorological Knowledge.

ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 7.45.—A. Chaston Chapman: The Yeasts, a Chapter in Microscopical Science (Presidential Address).

ROYAL SOCIETY OF ARTS, at 8.—Mrs. Graydon-Stannus: Irish Glass, Old and New.

SOCIETY OF GLASS TECHNOLOGY (at Birmingham).

THURSDAY, JANUARY 22.

ROYAL SOCIETY, at 4.30.—Prof. H. C. H. Carpenter and Miss C. F. Elam: Experiments on the Distortion of Single-Crystal Test Pieces of Aluminium.—J. V. Howard and S. L. Smith: Recent Developments in Tensile Testing.—R. L. Smith-Rose and R. H. Barfield: On the Determination of the Directions of the Forces in Wireless Waves at the Earth's Surface.—*Papers to be read in title only.* Prof. D'Arcy Thompson: On the Thirteen Semi-regular Solids of Archimedes, and on their Development by the Transformation of Certain Plane Configurations.—W. S. Farren and Prof. G. I. Taylor: The Heat developed during Plastic Extension of Metals.—U. R. Evans: The Colours due to Thin Films on Metals.—A. Campbell: On the Determination of Resistance in Terms of Mutual Inductance.—S. Butterworth: On the Alternating Current Resistance of Solenoidal Coils.

LINNEAN SOCIETY OF LONDON, at 5.—The President and R. D'O. Good: The Recent Meeting in Canada of the British Association.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—J. S. Huxley: The Courtship of Animals and its Biological Bearings (II.).

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Major R. V. Southwell: Some Recent Work of the Aerodynamics Department, National Physical Laboratory.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. W. Clothier: The Design of Electrical Plant, Control Gear and Connexions for Protection against Shock, Fire and Faults.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates Meeting) (at Luton), at 7.30.—A. O. Seward: Carburation.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (and Society of Chemical Industry, Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Prof. J. Hendrick. The Alsatian Potash Mines.

FRIDAY, JANUARY 23.

ROYAL DUBLIN SOCIETY, at 4.30.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Dr. B. W. Clack: An Investigation of the Measurement of Small Differences of Refractive Index by the Rayleigh Interferometer.—J. Taylor and W. Clarkson: A Study of the Production of Flashing in Air Electric Discharge Tubes.—C. R. Darling: A Kinematographic Study of Plateau's Spherule (Demonstration).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith. Recent Discoveries of Fossil Man (III.). Recent Discoveries in Australia and Java and their Bearing on the Theory of Man's Evolution.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Reports to the Cutting Tools Research Committee.—Dr. W. Rosenhain and A. C. Stanney: Flow and Rupture of Metals during Cutting.—Dr. T. E. Stanton and J. H. Hyde: An Experimental Study of the Forces exerted on the Surface of a Cutting Tool.

THE SOCIETY OF DYERS AND COLOURISTS (London Section) (at Australia House, Strand), at 7.—J. Craft: Incorporation of Eulan into Woollen Textiles and other Fabrics, Permanent Protection against Moth Damage (Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Lantern Lecture.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. H. Parsons: Boiler-house Records and their Practical Value (Lecturette).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—E. A. Eborall: Railway Electrification in Switzerland (Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—T. Lewis: Gas Producers.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Prof. A. M. Carr-Saunders: The History of the Limitation of Numbers.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. A. W. Crossley: Science and the Cotton Industry.

PUBLIC LECTURES.

MONDAY, JANUARY 19.

KING'S COLLEGE, at 5.—Dr. J. A. Hewitt: Carbohydrate Metabolism (Succeeding Lectures on January 26, February 2, 9, 16, 23, March 2, 9.)

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: International Problems of Industry (I.) Historical Background, and the Competitive Element in the Determination of Conditions of Labour.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Lectures on the Anatomy and Physiology of the Sympathetic Innervation of the Striated Muscle, prepared for delivery by the late Prof. J. Hunter. (Succeeding Lectures on January 26 and February 2.)

KING'S COLLEGE, at 5.30.—Prof. E. V. Appleton: The Rôle of the Atmosphere in Wireless Telegraphy.

TUESDAY, JANUARY 20.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Leeds University), at 6.—Prof. A. Gilligan: The Geology of Yorkshire: Cleveland and the Yorkshire Wolds.

WEDNESDAY, JANUARY 21.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—W. H. Ansell: The Principles of Design as applied to Buildings.

KING'S COLLEGE, at 5.30.—M. L. W. Laistner: The Decay of Geographical Knowledge and the Decline of Exploration, A.D. 500–600.

UNIVERSITY COLLEGE, at 5.30.—H. Jenkinson: The Public Record Office and Archives.

THURSDAY, JANUARY 22.

UNIVERSITY COLLEGE, at 5.—Dr. A. S. Parkes: The Physiology of Reproduction. (Succeeding Lectures on January 29, February 5, 12, 19, 26.)

FRIDAY, JANUARY 23.

UNIVERSITY COLLEGE, at 11 A.M.—Prof. A. V. Hill: The Physiology of Muscle and Nerve. (Succeeding Lectures on January 30, February 6, 13, 20, 27, March 6, 13, 20, 27, April 3, 10.)

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Philosophical Hall, Leeds), at 8.—Prof. D. M. S. Watson: The Origin of Land Vertebrates.

SATURDAY, JANUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: Rough Stone Monuments and their Builders.



SATURDAY, JANUARY 24, 1925.

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2882, VOL. 115]

Fuel Research.

ONE of the most important of the subjects dealt with in the recent annual Report of the Committee of the Privy Council for Scientific and Industrial Research is that of fuel. Fuel is in Great Britain practically the sole source of the power which is essential to all our large industries. The only fuel of national importance produced at the present time is coal, and on the economic use of our diminishing supplies of it the prosperity of the country largely depends. This is now becoming a platitude, but the complexity of the problem involved is by no means realised by many popular writers on the subject.

The coal as it exists in the ground is a highly complex substance, and its constitution varies very widely, even through the thickness of a single seam. The quantity and nature of the volatile content, of the "ash" content, the coking power, the moisture content, and the calorific value all vary, as well as the amount of impurities such as sulphur, arsenic, or phosphorus which, while never intrinsically large, may for some purposes be very important. Analyses and determinations of calorific value, while giving much useful information, by no means give all the information required to determine the suitability of a coal for any given purpose. For example, it is obvious that a large ash content is undesirable, as the cost of carriage of the ash is the same as that of the coal, and in addition the ash has to be removed from the furnace and disposed of. This is, however, not the whole story. The melting-point of the ash is of importance, and while, for example, a low melting-point is not objectionable for domestic purposes, as it tends to prevent the formation of a powdery ash in the grate, a high melting-point is wanted for industrial purposes to prevent the too ready formation of clinker. Similarly, the composition of the ash may have a considerable influence on the refractory linings of the furnace. Recent investigations indicate that the ash may have subtle effects on the decomposition of the coal under heat, and further investigation may show that these effects are of great importance to the carbonisation industries.

Of recent years increased attention has been given to the removal of ash by washing or other purification processes, but much work remains to be done before it will be possible to recommend the best methods to adopt and the degree of purification that is economically desirable.

Much fine coal is left underground, or if brought up is at present unsaleable, and this constitutes a great waste of potential resources. The difficulty in using this coal is due partly to the high ash content and partly to the difficulties of transport and storage.

There is here a large field for useful research which embraces coal-washing, the causes of spontaneous combustion, and methods of briquetting, but there can be no single solution that will suit all fine coals. The solution must depend on the circumstances of each case, and a knowledge of these circumstances can be gained only from a survey of the physical and chemical characteristics of the various coal seams.

Another field of research which has as yet been but little explored is that dealing with metallurgical coke. The prosperity of the great iron and steel industries depends very largely on the possibility of reducing the cost of the fuel per ton of metal dealt with It is well known that cokes vary widely in their properties and in the economy with which they can be used, but so far, it has proved impossible to say in detail why one coke is better than another It is, then, of importance to find out (*a*) the properties of the coke that are of fundamental importance for metallurgical purposes, (*b*) the characteristics of the raw coal necessary to obtain these properties in the coke, and (*c*) the best method of obtaining the coke from the coal. For this purpose again a knowledge of the characteristics of the various coal seams is necessary before the problem can be fully solved

For metallurgical purposes raw coal is often unsuitable, but there are many other purposes where, while raw coal could be used, it is both convenient and economical to treat the coal so as to obtain other forms of fuel. The real object of all such treatments is to increase the availability of the heat units, *i.e.* to provide a fuel which can be more efficiently and conveniently transported and utilised than can the coal itself. The most widely used of such treatments is the carbonisation of coal to produce coal-gas and coke, the manufacture of which incidentally produces as by-products a large proportion of the raw material required by our chemical industries. The importance of this and of the smokeless nature of the gas and coke needs no emphasis here, but the gasification of all our coal would not be advantageous, even if all coals were suitable for the process. There is necessarily a thermal loss in any carbonisation process, and this loss can only be justified if it is compensated for by the more economical use of the heat units remaining, and in economy of use must be included economy of transport. The over-all thermal efficiency of a carbonisation plant plus a boiler plant, where the combustible products of the carbonisation are all immediately burned under boilers, is necessarily lower than that of a boiler plant utilising the raw coal.

The carbonisation of coal at "low temperatures" has been much to the fore of recent years, with the object of obtaining home supplies of oil and a smokeless solid fuel for domestic and industrial purposes, and considerable progress has been made towards the solution of its particular problems. Here again it is not all coals that are suitable for the purpose, and all suitable coals will not respond to the same treatment.

Whatever aspect of the fuel problem is considered, it is found that a solution of its problems, if looked at from a national point of view, depends on a fuller knowledge of the characteristics of the coal available than we at present possess. The Fuel Research Board is therefore correct in placing the physical and chemical survey of the national coal resources in the forefront of its programme, and it is gratifying to learn that the Government has decided that this work shall "be pressed forward at the maximum speed compatible with obtaining proper value for the expenditure."

The Fuel Research Board considered "that the actual work in the coalfields would best be carried out by means of local committees, the personnel of which included colliery owners, managers, consumers, and representatives of the Board and of the Geological Survey. By this means it was hoped to obtain the sympathetic co-operation of the owners and managers without which the work could not be carried on." In the two areas in which local committees have been formed, the report states that this co-operation has been given freely. It is to be hoped that the same spirit will animate the owners and managers in the other coalfields of the country. There need be no fear that more economical methods of utilising our fuel resources will be detrimental to the coal-producing industry, as the cheapening in the cost of our manufactured products which would result would lead to a greater demand for them, and so keep up the demand for the coal, to say nothing of the possibilities of enabling the collieries to find favourable markets for coal at present unsaleable.

The practice adopted by the Survey, of taking samples in the form of a pillar of coal through the whole thickness of the seam, enables each portion of the seam to be examined separately, and thus brings out any peculiarities that may exist in the different layers. It has already been abundantly shown that very striking differences may exist, and that in some cases the different layers may be advantageously separated before the coal is marketed, the extra labour involved being more than compensated for by the increased value of the coal. The work of the Survey is, however, not confined to the laboratory examination of small samples, and in suitable cases samples of several hundred tons may be tried out to ascertain their behaviour in full-scale plant.

Logarithms de Luxe.

Logarithmetica Britannica: being a Standard Table of Logarithms to Twenty Decimal Places. By Alexander John Thompson. Part 9: Numbers 90,000 to 100,000. (Issued by the Biometric Laboratory, University of London, to commemorate the Tercentenary of Henry Briggs's publication of the "Arithmetica Logarithmica," 1624.) Pp. xviii + 100. (Cambridge: At the University Press, 1924.) n.p.

ON the appearance of the first section of this important book, it is appropriate to give some account of the evolution of logarithmic tables.

Henry Briggs, the computer of the first great table of logarithms, was born about 1556 at Warley Wood, a hamlet near Halifax, Yorkshire. He showed signs of mathematical ability at an early age, and proceeded to St. John's College, Cambridge, in 1579. Briggs was elected a fellow of his College in 1588 and remained there until 1596, when he became the first reader in geometry at Gresham College in London

In 1614 Napier's first work on logarithms was published, the "Mirifici Logarithmorum Canonis Descriptio." This book came into Briggs's hands soon afterwards: he began to read it with interest, which was changed into enthusiasm by the time he had finished He soon perceived that the system of logarithms which would now be described as having 10 for base would be more convenient in use than that on which Napier's system had been calculated After describing this improvement to his classes, Briggs travelled to Edinburgh in 1615 and discussed it with Napier. He remained there a month as Napier's guest, and on his return to London busied himself in calculating logarithms according to the new plan. In 1616 he again visited Napier, taking with him the calculations he had made. The results of these calculations were printed in 1617, for the benefit of his personal friends, as "Logarithmorum Chilias Prima." In this rare brochure were given the logarithms of the first 1000 numbers to 14 decimal places Specimen pages are reproduced as a frontispiece to the work now under notice.

In 1619 Briggs became the first Savilian professor of geometry at Oxford, settling at Merton College, and resided there for the remainder of his life. He continued to carry on his computing, and in 1624, after about eight years' labour, produced the "Arithmetica Logarithmica." This work contains the logarithms to 14 decimal places, together with their first differences, of all numbers from 1 to 20,000 and from 90,000 to 100,000. It is accompanied by a masterly introduction, in which the construction of tables, interpolation by means of differences, and other matters of the greatest importance were dealt with for the first time. Although this work is now very rare and costly, it is said that the edition of the tabular portion was too large and that surplus copies were hawked in the streets of London at eighteen pence each After completing this great book, Briggs, with the help of a few friends, began to fill up the large gap of 70,000 logarithms which had been left. These were almost completed when, in 1628, Adrian Vlacq, a Dutchman, published the logarithms of the first 100,000 numbers to 10 decimal places, in a book which he also called "Arithmetica Logarithmica." Although Vlacq had only copied 30,000 logarithms from Briggs's book (cutting them down from 14 to 10 decimal places) and had calculated 70,000 himself, he described his work merely as a second edition. Briggs may have felt some disappointment at the way in which he had been forestalled by Vlacq: he seems, however, to have been relieved that the burden of printing 70,000 logarithms had been removed from his shoulders. In such circumstances most men would have given up computing; but not so Briggs. When about seventy years of age, he commenced another great work, the logarithms of the trigonometrical functions, and had almost completed it at the time of his death in 1631 Vlacq printed these logarithms at his own expense and published them in 1633 under the title of "Trigonometria Britannica."

No complete reprint of Briggs's great table of the logarithms of numbers has ever been made, and, up to last year, only two 10-figure tables have been published since Vlacq produced his table in 1628 The need for an extended table has long been felt, and the present work is intended to meet this need Logarithms to a few figures are seldom used in present-day computation, and the modern calculating machines often fail to give results of sufficient accuracy without great expenditure of labour In statistical and computing laboratories—especially where new tables have to be prepared for publication—the original Briggs or original Vega are in greater demand than more contracted logarithmic tables. Yet their high cost, their rarity, and uncorrected errors have long rendered new tables desirable.

No tribute more fitting than the publication of this new 20-figure table could be paid to the memory of a great man on the tercentenary of his greatest work. After extensive inquiries, the compilers have been unable to trace any portrait of Briggs for reproduction in the book.

The section now issued gives the first 20 figures in the mantissa of log N for each integer N from 90,000 to 100,000, together with second and fourth central differences for use in interpolation. First differences are not tabulated: their inclusion would have greatly

increased the bulk of the volume and rendered the cost of producing it prohibitive. It is intended to issue eight similar sections at intervals of a few months to include the range from 10,000 to 90,000.

Linear interpolation is sufficient to evaluate the logarithm of any number, given as a decimal, correct to 10 figures—and the calculation involved is slight Methods for evaluating a logarithm to 15 or 20 decimals are described on the assumption that the computer has access to a calculating machine. Such machines are now used widely, and the amount of work involved is less serious than would appear at first sight Naturally, a computer who undertakes calculations to 20 significant figures must be prepared for a certain amount of arithmetical labour. To evaluate log γ where $\gamma = 0\ 57721\ 56649\ 01532\ 86061$, first put $\gamma/a = \gamma/0{\cdot}6 = 0\ 96202\ 61081\ 69221\ 43435$, which is within the range of the tables. Next, $\gamma/a = 0{\cdot}96202\ 61 \times 1\ 00000\ 00084\ 91683\ 78524 = bc$ Log b is found from log 96202 and log 96203 by Prof. J. D Everett's central-difference interpolation formula The numerical coefficients involved are taken from an earlier publication of the Biometric Laboratory, prepared by the same author (A J. Thompson's "Table of the Coefficients of Everett's Central-Difference Interpolation Formula," Tracts for Computers, V., Cambridge University Press, 1921) A short supplementary table gives the logarithms of numbers between 10^{10} and $10^{10}+100$, and log c is obtained by interpolation between log $(10^{10}+84)$ and log $(10^{10}+85)$. Finally, log γ = log a + log b + log $c = \bar{1}\ 76133\ 81087\ 83167\ 61054$, and this is correct to the twentieth decimal place

Of the scheme which has been begun we have but one criticism to offer We think the table should be extended so as to include 21-figure logarithms of integers between 100,000 and 110,000. The $(k+1)$th figure of N when $1{\cdot}0 < N < 1{\cdot}1$ has only the same significance as the kth figure in the main body of the table. If α, β are small and positive,

$$\delta = \log(1+\alpha) - \log(1+\beta) = \mu(\alpha-\beta),$$
$$\delta' = \log(1-\alpha) - \log(1-\beta) = -\mu(\alpha-\beta)$$

approximately Since, however,

$$1+\alpha = 1{\cdot}0\ \ldots\ ,\ 1+\beta = 1\ 0\ \ldots,$$
$$1-\alpha = 0{\cdot}9\ \ldots,\ 1-\beta = 0{\cdot}9\ \ldots,$$

the tabulated value of δ, when k-figure logarithms are used throughout, will be ten times as great as the tabulated value of δ' The value of the $(k+1)$th figure in the logarithm of a number just exceeding unity is apparent in many applications of the tables, *e.g.* in actuarial work and in stability problems in dynamics. This need has been recognised by the compiler of Chambers's 7-figure tables, which include 8-figure logarithms of numbers between 100,000 and 108,000.

Both Mr. Thompson and the Director of the Biometric Laboratory in University College (Prof. Karl Pearson), London, are to be heartily congratulated on the publication of this book, the former for his enthusiastic energy which has not been damped by the seriousness of the labour involved in calculating the table, and the latter for undertaking the production of it. Such an enterprise is not one of profit: a wide readiness on the part of the mathematical world to commemorate with the promoters the tercentenary of the "Arithmetica Logarithmica" can alone ensure the success of the venture.

Earthquakes and Geology.

La Géologie séismologique: les tremblements de terre. Par le Comte de Montessus de Ballore. Pp. xiv + 488 + 16 planches. (Paris. Armand Colin, 1924.) 50 francs.

TO those who value the work of M. de Montessus de Ballore, this posthumous volume will be a welcome surprise. It forms the third of a well-known series. The first, "Géographie séismologique," based on the distribution of 171 thousand earthquakes, was published in 1906. The second, "La Science séismologique"—the most detailed treatise that we possess on earthquakes in general—appeared in 1907. Then followed a long gap during which the author was mainly occupied in organising the Chilian Seismic Service. In the evening of his active life he has written the volume before us, the text of which he lived to send to the press, though the task of proof-correcting and the selection of the illustrations were done by others. M. Pierre Termier has contributed the preface, and M. Armand Renier a short biography of Montessus and a useful list of his books and memoirs.

"La Géologie séismologique" is less a treatise on the origin of earthquakes than a series of descriptions of important earthquakes with special reference to the phenomena of geological interest. Montessus divides earthquakes into two main classes, glyptogenic or geological and external dynamic earthquakes. The former are further rearranged into epeirogenic, tectonic, and epeirogenic and tectonic, according as the surface displacements are vertical, horizontal, or vertical and horizontal combined. Under the term external dynamic earthquakes are included volcanic earthquakes and rock-fall earthquakes (tremblements de terre d'écroulement). Between the two classes lie the majority of earthquakes, those which produce no apparent individual effect on geological structure, and which he therefore leaves unconsidered. He regards the connexion of these shocks with glyptogenic earthquakes as a very plausible induction and nothing more. Yet if, as in the Inverness earthquakes of 1901, the

epicentres can be traced shifting to and fro along a line of fault, if in their migrations they follow the same law as the after-shocks of the Japanese earthquake of 1891, the conclusion that they are glyptogenic is surely more than plausible. In any case, do not such earthquakes deserve consideration as much as purely volcanic earthquakes (to which 62 interesting pages are given), and more than rock-fall earthquakes, which are unimportant from a geological point of view?

The terms adopted by Montessus are, in one or two respects, unfortunate. The word *tectonic* has hitherto been applied to all earthquakes due to the growth or moulding of the earth's crust There seems no valid reason for confining it to earthquakes connected with horizontal displacements The name of the third class, epeirogenic and tectonic, is cumbrous. Terminology, however, is of less consequence than the classification implied, which is a useful one.

Under the heading of epeirogenic earthquakes are included the great earthquakes of New Madrid in 1811, Assam in 1897, and Kangra in 1905. The Chilian earthquakes of 1822, 1835, and 1837 would have been added if it were certain that they were accompanied by elevation of the land. But the author accepts Suess's arguments—which seem to me inconclusive—and considers that those who saw definite traces of elevation were mistaken. Possibly he would have revised this opinion could he have known of the recent observations in Japan (see NATURE, January 10, p 65) on the later settling of elevated tracts.

Typical examples of tectonic earthquakes are the Owen's Valley earthquake of 1872, the Sumatra earthquake of 1892, and the Californian earthquake of 1906; those of epeirogenic and tectonic earthquakes are the New Zealand earthquakes of 1848 and 1855, the Japanese earthquake of 1891, and the Alaskan earthquakes of 1899. Of volcanic earthquakes, accounts are given, among others, of the Hawaiian earthquake of 1868, the Ischian earthquakes of 1883, etc., and earthquakes connected with various eruptions in Japan and the Philippine Islands.

The chapters in which these earthquakes are described form, roughly, two-thirds of the book. Of the remaining third, half is given to secondary glyptogenic effects of earthquakes, such as the isostatic readjustment of alluvial plains, the subsidence of coasts and submarine talus (including accounts of the Jamaica earthquakes of 1692 and 1907 and the Messina earthquake of 1908), and avalanches, effects on glaciers, etc. The latter half contains interesting discussions of some miscellaneous questions, such as changes in topography produced by earthquakes, the influence of geological conditions on the trend of isoseismal lines, the migration of epicentres, and the geographical distribution of earthquakes. The last two chapters might well have been longer; perhaps they were hurriedly finished in the closing days of the author's life. Of the migration of epicentres, two examples only are given, of the Calabrian earthquakes on a small scale, and of earthquakes along the unstable circum-Pacific circle on a large scale. A page or two on the migration of after-shock epicentres, which is merely touched on, would have been a welcome addition. As the author remarks, such a study would tend to nothing less than the prevision of earthquakes. Still more effective for the purpose would have been a study of the migration of fore-shock epicentres. For example, in those of the Japanese earthquake of 1891, the distribution of epicentres during the years 1890 and 1891 outlined the future zones of dislocation and clearly pointed to the coming earthquake.

There are few omissions of any consequence. Some have been suggested above, the principal one being the absence of reference to shocks of small intensity. In the account of the Ischian earthquakes, Johnston-Lavis's monograph is not mentioned The important part played by after-shocks is not considered in detail. Such omissions, however, are of small account in comparison with the great service that the author has rendered. Here, under one cover, are gathered materials collected from widely scattered sources. Few, if any, writers have had Montessus's acquaintance with the literature of earthquakes, and there are not many libraries, either public or private, that contain all the works from which he has drawn his admirable illustrations. In no way is this last volume inferior to its two predecessors. To have produced it is a worthy ending to a life of unceasing labour in the cause of science C. DAVISON.

Egyptian Mummies.

Egyptian Mummies. By Prof. G. Elliot Smith and Warren R. Dawson. Pp. 190+65 plates. (London: G. Allen and Unwin, Ltd., 1924) 25s net.

PROF. ELLIOT SMITH and Mr Warren Dawson have written a very interesting and useful book on mummies, which appears in a most attractive guise (except for some of the illustrations). Its outward show would seem to indicate that it is intended for the general reader who is "keen on" mummies and mystery rather than for the scientific student, but the latter will find in it much detail of purely scientific (and more especially pathological) interest, besides a sketch of the history of the practice in Egypt which, being written by the chief authority on the subject, can be accepted without question. The book takes the place of the old and out-of-date work of Pettigrew,

which hitherto has been almost the only treatise specially devoted to the subject, though the archæological reader will find a very useful chapter on the matter in Sir Ernest Budge's long out-of-print book, "The Mummy."

On the archæological side the book is unexceptionable, until the writers (as we fear was to be expected) launch into a dogmatic statement (rather than, as one would have preferred, a reasoned justification) of the now well-known "diffusionist" theory of the spread of all human culture from Egypt, even so far as America via Polynesia, of which Prof. Elliot Smith is the protagonist. They inform us, as if the matter were settled fact, that mummification spread via India to Malaysia, Torres Straits, Polynesia, and finally Peru and Mexico, "and became widely diffused in both continents of America" (pp. 164, 165). There is no peradventure in this matter for these authors: it is as settled a fact for them as is any religious dogma for its *croyants*; and is calmly assumed to be a known fact Let it first be proved to be even a probable theory It is not yet accepted as such by the archæologists. It may eventually be proved to be a probable theory; we do not say that it will not or cannot, because we have no *beliefs* on these subjects whatever: we consider *beliefs* about anything relating to the early history of man and the origins and diffusion of his culture to be totally unjustified and unscientific: one is still dimly groping in the dark of theories and hypotheses, not dealing with mathematical certainties The "diffusionist" theory is just one of these hypotheses which *may* be true but cannot yet be proved to be so, any more than any other theory of the kind, and until it is proved so, should not be stated as uncontroverted fact, which it is not

On the archæological side, the authors clearly state the extremely probable origin of mummification in the drying-up of the body in the hot rainless desert sand of the primitive Egyptians' graves, which first gave the idea of preserving the dead in the pathetic hope that they could in some muddle-headed way be made to live again It was a protest against death, which the Egyptians loathed: "O ye who love life and hate death," begins the prayer which summons the living to come and bear their offerings of food to the tomb that the dimly imagined "double" or *ka* of the deceased might feed upon it and somehow "live." Then we are told how true mummification began with the addition of preservatives and bandages, first only in the case of the king and then of his nobles. The common people were not embalmed even in the most summary way until much later. Then we see how the practice grew and developed, until it reached its apogee in some respects in the time of the XVIIIth–XIXth Dynasties, though it was not until the XXIst that the mummy became a sort of human statue much like those proposed by Jeremy Bentham. Finally we see how it declined until Christianity abolished it, after a short struggle with those Egyptian Christians who wished to retain their ancient national practice.

Chapters on the funerary furniture and amulets of the mummy, the spells of the Book of the Dead, etc., are given, and a useful list of those kings whose tombs and mummies are known.

The pathological side of the inquiry is, of course, well represented, and physicians will find interesting the proofs of the existence of dental and tubercular caries, leprosy, Pott's disease, gall-stones, osteo-sarcoma, mastoid disease, talipes, and *Dystocia adiposo-genitalis* among the ancient Egyptians, to whom, however, syphilis seems to have been unknown. Prof. Elliot Smith gives several photographs of such pathological conditions.

The photographic illustrations are good, but the non-photographic ones are very unsatisfactory woodcuts after well-known photographs which surely might themselves have been used. Fig 16 is a case in which one of the least unpleasing mummies has been made hideous in the woodcut, which is drawn from an admirable photograph. We are sorry to see these ugly blemishes in a most useful book. H. R. HALL.

Our Bookshelf.

Allen's Commercial Organic Analysis. Edited by Samuel S. Sadtler, Dr. Elbert C. Lathrop, and C. Ainsworth Mitchell. Vol. 2: *Fixed Oils, Fats and Waxes, Special Characters and Methods, Butter Fat, Lard, Linseed Oil, Higher Fatty Acids, Soap, Glycerin, Wool-fat, Cloth Oils, Sterol Alcohols.* Fifth edition, revised and in part rewritten. Pp. ix + 807. (London: J. and A. Churchill, 1924.) 30s. net.

A PERIOD of fourteen years has elapsed since the publication of the equivalent volume in the last edition of Allen's "Commercial Organic Analysis." The reputation of this standard text-book is definitely upheld in the new volume. A comparison of the old and new shows that a thorough revision of data from the analytical investigation of fixed oils, fats, and waxes has been made, resulting in a considerable increase in the size of the book. A part of the increase is due to the fact that, while giving the latest and best methods, the older methods have in many cases been also intentionally retained. The section on the special characters and modes of examination of fats, oils, and waxes has been doubled in size and now covers nearly half the book, while some of the smaller sections show a fourfold expansion. Many subjects practically unknown in commercial analysis when the previous issue appeared (*e.g.* fermentation glycerin, vitamins, montan wax, etc.) have now their place in the new edition.

In the refined glycerin section, a reference is given

to the excellent "Ardeer Analytical Methods" book, but, so far as the reviewer is aware, this analytical process book is only available for private use in the Nobel Laboratories.

The book, which is printed in the United States, is excellently produced and the price reasonable compared with present-day standards. The increase in cost compared with the price of the former edition is less than proportional to the increase in size.

J. REILLY.

Evenings with the Stars. By Mary Procter. Pp. ix + 212 + 8 plates (London: Cassell and Co., Ltd., 1924.) 10*s.* 6*d.* net.

THIS work is not to be confused with the "Children's Book of the Heavens" by the same author. It is an entirely new work and is intended for amateur astronomers, and for those who wish to learn something about the constellations, both in their appearance in the sky, and in the wealth of legendary lore connected with them. Accordingly, the division is into twelve evenings or chapters, each dealing with a certain number of constellations near to one another in the sky, until the whole of the constellations visible in northern latitudes have been passed in review. The work is, in a spirit of filial piety, dedicated to the father of the author, the late distinguished astronomer, R. A. Proctor, "who taught me how to know and love the stars." From him she has inherited another gift, that of lucid and interesting description.

Each chapter is illustrated by a series of very clear and well-drawn original charts, by means of which the reader and student is safely piloted through the constellations. After a description of the constellation, the chief objects of interest are pointed out, with many aptly-chosen illustrative quotations from literary and legendary allusions to such objects. Appended to the twelve chapters is an interesting poem, the "Voices of the Suns," by the father of the author. There is also an excellent index, and in addition eight beautiful plates of nebulæ. The frontispiece in particular is a fine reproduction of the great cluster in Hercules, as photographed at the Dominion Astrophysical Observatory with the 72-inch reflector.

The book, too, is very well printed. Both for its astronomical and its literary excellence it can be highly recommended, and is deserving of a wide circulation. It is the work, too, of an expert.

A. L. C.

The Soil and its Management. By Prof. Merritt F. Miller. Pp. vi + 386. (Boston and London: Ginn and Co., 1924.) 7*s.* 6*d.* net.

PROF. MILLER'S book is designed for schools teaching vocational agriculture and for short-course students in agricultural colleges, and forms an admirable introductory course in agriculture. Little or no acquaintance with chemistry and other sciences is assumed. The author has succeeded notably in avoiding technicalities and has produced a most interesting and readable account of soils, soil fertility, and soil management without loss of clearness or accuracy.

The general arrangement is not very different from that adopted in most text-books dealing with the soil, but the treatment is unusually full for an elementary work, and the constant reference to farm practice and to observations and experiments which may readily be made on the farm and in the countryside is an attractive characteristic. At the end of each chapter there is a series of questions, together with skilfully selected practical exercises, both in the laboratory and in the field, and "home projects" for the benefit of the boy who lives on a farm. There are also references to more advanced books dealing with the various aspects of the subject. The numerous illustrations from photographs are another special feature: they are well reproduced and are very much to the point—particular mention may be made of the little series of pictures showing the crops in different rotations.

The author writes for American students and with American farming practice in view, and there is a good deal that is not directly applicable to conditions in Great Britain; but it is a work which all who have to do with the elementary teaching of agriculture will find most useful.

C. T. G.

Butterflies of India. By Chas. B. Antram. Pp. xvi + 226 (Calcutta and Simla: Thacker, Spink and Co., 1924.) 30 rupees.

THIS book is intended for the uninitiated, and its primary object is to illustrate all the Indian butterflies, except a few which are very closely alike. More than 500 species are dealt with, leaving the Lycænidæ and Hesperiidæ for treatment in a second volume. A few notes on the collection and preservation of specimens are given, and the remainder of the book is occupied with short and, so far as possible, non-technical specific descriptions. The characters given for three out of the four families are popularised, we think, to the extent of inefficiency, while the Nymphalidæ are not diagnosed at all. Generic keys or tables are dispensed with, no doubt on account of the difficulty of translating them into non-technical language. The reader, therefore, needs to compare his specimens with the illustrations and descriptions until he alights upon the correct species. After a little practice he will probably experience no great difficulties in doing so.

The book is well produced and will, no doubt, prove to be a useful popular guide for the many collectors of these insects scattered through India. On p. 38 there is a description of a new species of Parnassius from Tibet: it is hoped that the author will also publish a technical diagnosis of the insect, if he has not already done so, in some scientific periodical.

Lehrbuch der anorganischen Chemie. Von Karl A. Hofmann. Funfte Auflage. Pp. xiv + 761 + 7 Tafeln (Braunschweig: F. Vieweg und Sohn A.-G., 1924.) 17·50 gold marks.

PROF. HOFMANN'S text-book has been carefully revised and brought up-to-date. It gives a clear and fairly detailed account of the subject along recognised lines, including the rarer elements, and will be found useful by advanced students. As in most German text-books, a section on explosives is added. It gives an impression that German students make a special study of this subject.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dutch Pendulum Observations in Submarines.

In the letter from Mr. Bowie on the subject of Dr. F. A Vening Meinesz's pendulum observations on board a submarine, which appeared in NATURE of December 27, 1924, p 930, there is a passage which seems to me to suggest a wrong idea of Dr Meinesz's method and thereby perhaps to engender doubts as to the possible accuracy of his results

Mr Bowie quotes the following pargraph from a paper which he presented at the Pan-Pacific Scientific Congress of 1920 "It is hoped that a satisfactory apparatus may be devised for determining the intensity of gravity at sea, using special vessels or commercial vessels There are several types of apparatus in existence, but no one of them gives results of sufficient accuracy for the study of isostasy The writer suggests that it may be possible to obtain a fair value of the intensity of gravity at sea by the use of the land apparatus properly mounted on a vessel. The apparatus would have to be swung in double gimbals and should be placed near the point of minimum translation resulting from the pitching and rolling of the vessel," and adds, "It was with great satisfaction that I read that Dr. Meinesz had accomplished the accurate determination of gravity at sea with the use of pendulums No doubt he arrived at the conclusion that the pendulum could be used independently of my suggestion in 1920"

The passage gives the impression that Dr. Meinesz's method consists of so mounting the apparatus as to reduce the disturbance due to the pitching and rolling of the vessel to a negligible quantity But this is not the method at all, and indeed one may reasonably doubt whether it would ever be possible to produce on board a ship a stillness at all comparable to that enjoyed by what the inhabitants doubtless consider the *terra firma* of the western part of Holland, yet in that region the instability of the ground is such that Dr Meinesz found it impossible to obtain any result by means of the pendulum apparatus used in the ordinary way, as the disturbance of the time of oscillation of the pendulum caused by the movements of the ground was far too great. The same difficulty has been met by other observers in places where the conditions are similar to those found in western Holland

To overcome this difficulty, Dr. Meinesz thought of the ingenious plan of swinging two pendulums simultaneously on the same stand. He showed by analysis that from observations of the times of swing of the two disturbed pendulums it was possible to deduce the time of swing of a hypothetical pendulum, the length of which is constant so long as those of the two real pendulums do not vary, and the time of swing of which is independent of the disturbances suffered by the real pendulums The two pendulums are swung in the same plane and on the same support; that is to say, their knife-edges are parallel and the surfaces on which they swing are rigidly connected. The idea of the method, to state it quite roughly, is that the two pendulums suffer equal but opposite disturbances, so that a mean undisturbed value is deducible

This method was found to give excellent results on the slightly unstable soil of Holland, and has also been found to give good results on a submarine where the instability, though much less than that of a ship floating on the surface, is nevertheless enormous compared with the least stable of the land stations.

I cannot believe that attempts to reduce the effects of a ship's movements by such devices as gimbals and the like would ever have been successful in freeing a pendulum, swinging by itself, from disturbances too great to be tolerable, but Dr. Meinesz introduces a new idea quite different from that of damping out the effects of the movements.

It is very desirable that the originality of Dr. Meinesz's method should be recognised and that he should have full credit as the sole inventor of a plan which seems to have solved the problem of the determination of gravity at sea.

G. P. LENOX-CONYNGHAM

Trinity College,
Cambridge, December 30.

On a Connexion between the Spectra of Argon and Ionised Potassium.

THE quantitative relations between the spectra of argon and ionised potassium have been for some time a subject of investigation in the Amsterdam Laboratory The available observations are chiefly due to Schüllinger (*Wiener Sitz Ber* 118, 605, 1909), McLennan (Proc R.S, 100, 182, 1921), and Dik and Zeeman (*Proc Kon. Acad Amsterdam*, 1922, 1923). Schüllinger used a spark for the production of the K^+ spectrum, McLennan, as well as Dik and Zeeman, the electrodeless discharge. Dik and Zeeman got a rather pure K^+ spectrum, because with very intense discharges the arc lines were entirely suppressed, a result at variance with that of other observers The observations were obtained with a quartz spectrograph. The accuracy is, therefore, not sufficient for a scrutinising analysis, and observations with a grating spectrograph were projected

Prof Konen kindly informed us that in Bonn such measurements were already in hand, so that they were here postponed From the preliminary observations, Dik and Zeeman concluded that, in the spectrum of ionised potassium, constant differences of about 847 and 1696 were present, and this would point to a connexion with the red spectrum of argon (Rydberg). Afterwards the present authors (De Bruin and Zeeman, NATURE, Sept. 6, 1924, p. 352) investigated the blue spectrum of argon (accurate measurements of Eder and Valenta), and it appeared that a difference of about 846 here is also characteristic, as well as about 414 also found with the spectrum of K^+. Afterwards we found that Paulson (*Astr. Journ.*, 41, p. 75, 1915) had also hit upon the difference of about 846 in argon Recently, Dahmen (*Zeitschr. f. Phys.*, 29, 1924, p 264), of Bonn, has published measurements on ionised potassium, using a large grating, and potassium electrodes in an atmosphere of argon. In his experiments the arc lines are not absent, but his results are far more accurate.

From an examination of this new material, we have come to the conclusion that the difference of about 847 is not characteristic and probably cannot be maintained. The difference of about 1696 is present, a more accurate value being about 1712. Instead of the difference of about 414, we now find 418·2 for ionised potassium.

We have found some groups of regularly distributed lines exhibiting also regular distribution of intensities, a fact of some importance for the further analysis, because the intensities are closely connected with the inner quantum numbers. In the "quintets," the second component has the greater intensity, surpassing

always the first and third component. These groups of lines allow us to conclude that in Dahmen's observations some lines are absent which are present in Dik and Zeeman's tables

Some examples of "quintets" may be given here

I

I.	ν (Vacuum).		
2	20224·50	(D, Z)	
	1468 83		
5	21693 33	(G)	800·96
	1089·05		1507·00
3	22782 38	(G)	1980·01
	417 95		
4	23200 33	(G)	
	473 01		
5	23673 34	(G)	

II.

I	ν (Vacuum)		
2	21753 81		
	1468 82		
3	23222 63	(G)	891·04
	1089 18		1507·00
1	24311·81	(G)	1980·22
	417 82		
2	24729 63		
	473·22		
3	25202 85		

III

I	ν (Vacuum).		
4	22189 68	(G)	891·39
	1468 93		1507·04
5	23658 61	(G)	1980·18
	1088 79		
1	24747 40		
	418 25		
3	25165 65		
	473 14		
2	25638 79		

IV

I	ν (Vacuum)		
6	24178·63	(G)	891 80
	1469 57		1507 11
8	25647·80		1980·65
	1088·85		
2	26736·65		
	418·26		
6	27154 91		
	473 54		
5	27628 45		

V.

I	ν (Vacuum)		
(7)	23449 36	(G)	891·73
	1468 76		1507 11
1	24918 12		1980 61
	1088 88		
0	26007	(D, Z)	
	418 23		
1	26425 23		
	473 50		
1	26898 73		

(D, Z) means observed by Dik and Zeeman

(G) refers to Goldstein's observations of the "Grundspectrum" Goldstein (*Verh. deutsch. phys. Ges.* 321. 1907; 426 1910), who was the first to obtain the spectrum of ionised potassium, observed 16 lines in the red part of the spectrum Ten of these lines are incorporated in the "quintets" given

Further details will be published by one of us (de B.) on another occasion.

T. L. DE BRUIN.
P. ZEEMAN.

Amsterdam, December 29.

The Ages of Peat Deposits.

DR. W. H. PEARSALL'S article on this subject in NATURE of December 6 refers to the absence of definite forest layers in the Pennine peat, in contrast to the peat with tree layers described by Lewis and others Dr. Pearsall appears to have overlooked the fact, however, that both the age and composition of mountain peat may differ considerably from that of marsh peat, in which tree layers are invariably found, and the presumption is that the Pennine peat to which he refers belongs to the former class The absence of tree layers in mountain peat is general throughout Ireland, whatever it may be elsewhere. This is due, not to the elevation at which it is formed, but to the stratum on which it rests, and which is invariably a surface soil, not always waterlogged, but deficient in lime and other alkaline bases, and on which the ordinary decomposition of humus is retarded or checked altogether. Tree stumps of Scots pine and birch, and more rarely oak, occur under the mountain peat up to elevations of 1500 feet to 2000 feet, and in situations where trees could not attain a similar size or rate of growth to-day.

Dr. Pearsall states that tree layers are not necessarily an indication of climatic change, and I agree with him. But they are undoubtedly an indication of change in the soil or peat water upon which the tree layers subsist, and also of the level at which the water table stood when they were growing. These root layers invariably show a decreasing size and rate of growth the higher they stand above the water table of the marsh which gave rise to the peat formation. The question is somewhat complicated by the fact that in most mountain districts, marsh and mountain peat are intermixed over wide areas, the mountain peat covering the higher and better drained surfaces, and the marsh peat the depressions or hollows which were originally small shallow lakes. The former never contains definite root layers, the latter root layers up to the level at which the sphagnum peat was formed, indicating a point at which sterility prevented all plant growth except mosses, stunted heather, and similar plants

So far as I am aware, few investigators distinguish between these two types of peat, and when tree layers are found in the shallow marsh peat of mountain districts, the fact is overlooked that they may be distinctly older than the mountain peat lying between them, and *under*, but *not in* which the tree stumps occur on the natural soil It is highly probable that the mountain peat corresponds in age to the Submerged Forest period, and also to the margins of the deeper and larger bogs of Ireland and Scotland. In these margins Scots pine and oak are usually found mixed, but in the deeper layers oak is absent

It is possible that considerable errors may arise by assuming that Scandinavian peat is of the same age as that of Ireland and Scotland Existing peat could not have been formed until the final retreat of the ice sheet, but probably began immediately after that retreat in the form of plant growth in the shallow lakes and marshes. Thousands of years may have separated the final retreat of the ice from the British Isles and its retreat from Southern Scandinavia, and in the interval peat has been forming wherever the conditions were suitable, irrespective of climate, although climate must have affected its rate of growth. That peat formation is going on to-day can be seen in many parts of the north and west wherever stagnant water accumulates, or soil surfaces are leaching out Neither the marsh peat in the one, nor the mountain peat in the other, is necessarily an indicator of climate, but the root layers in and under the marsh peat suggest that it is of a much greater age than the mountain peat so far as the lower layers are concerned The sphagnum peat is evidently a more recent growth, and reaches a more or less definite height in relation to the average diameter of the bog.

A. C FORBES.

Forestry Branch,
Dublin

IN NATURE for December 6, 1924, Dr. W. H. Pearsall directed attention to the results which have recently been achieved in work on the Pennine peat of Yorkshire; and discussed some of the problems of correlation which arise. Several of the points raised demand further comment.

After enumerating and discussing the validity of the conclusions reached by Lewis for the Scottish Peat Mosses, Dr. Pearsall says: "Samuelsson has

reinvestigated the Scottish deposits and his main conclusions agree with those of Lewis." This statement might almost be described as a travesty of the facts. Samuelsson (Bull Geol. Inst Upsala, Vol. X. pp. 197-260) does indeed confirm the general *succession* established by Lewis; but even in this there is not entire agreement. (See, for example, p 222) Lewis's main conclusions are surely contained in his correlation of the peat succession with the later glacial and interglacial periods of the system devised by James Geikie, and with this correlation Samuelsson disagrees. In the early part of a critical discussion (see especially pp. 217-226) he says: "Lewis has started from Geikie's point of view and endeavoured to bring his results into accordance with Geikie's opinion as much as possible But by holding one-sidedly on to the correctness of Geikie's classification of the late quaternary history of Scotland, Lewis has been led to some conclusions that are certainly wrong."

The arguments of Geikie and Lewis for the interglacial age of part of the Scottish peat may be summarised thus:

(1) A submerged forest (with present day flora) underlies the carse lands of the Forth and Tay.
(2) These carse lands rise inland and pass into the gravels of the 45-50 ft Raised Beach
(3) Moraines have been seen resting on this beach.

Therefore, the Submerged Forest is earlier than the glaciation represented by the moraines. The Submerged Forest is taken to be represented in the Scottish peat by the Lower Forestian, the glaciation by the 2nd Arctic Bed (Lower Turbarian), a subsequent emergence by the Upper Forestian, and a further submergence (25 foot Beach) by the Upper Turbarian.

This beautifully sequential argument is utterly destroyed by the following considerations:

(1) There is no contemporaneity between the carse lands of the Forth and Tay and the gravels of the 45-50 ft. beach.
(2) There is no independent evidence for the emergence which is supposed to be represented by the Upper Forestian; and, in any case, Samuelsson has pointed out that no such emergence is necessary.

Not content with quoting results based on a miscorrelation, Dr Pearsall states: "Now along the Scottish coasts, the submerged forests are replaced by the 40-50 ft. beaches, also of Neolithic date. ." This is confusion worse confounded indeed! It is not that the results and conclusions of later workers are hidden away in obscure and widely scattered journals On the contrary, in Wright's "Quaternary Ice Age" (chap xvi.) there is a delightfully clear, concise and well-written presentation of the evidence bearing on the raised beaches and submerged forests of the British Isles Here it is plainly stated that there exists in Scotland a group of raised beaches, ranging from the 100 ft. to the 40 ft. level, which are in part contemporaneous with the existence of large glaciers, and that these are separated from the 25 ft. raised beach of Scotland, Northern England and Ireland, by a period of emergence in which the submerged forests grew. It is to this ("25 ft.") period of submergence that the carse clays of the Forth and Tay belong, and these clays, as well as the associated beach gravels, have been proved, in all cases where the relation can be observed, to overlie the Submerged Forest.

The 25 ft. beach contains Campignien implements exactly similar in type to those which are found associated with the kitchen middens of the maximum of the Littorina depression in Scandinavia; and, in Scandinavia, this Campignien industry is associated with pigmy flints of Tardenoisien type. This evidence appears to contradict Clement Reid's assignation of a Neolithic date to the submerged forest, which is quoted by Dr. Pearsall. In this connexion, however, it must be remembered that Clement Reid was not speaking of the submerged forests of Scotland and Northern England, and also that the submerged forests increase in number and in depth outwards from Scotland. The uppermost submerged forest of Southern England and Wales appears to be of Neolithic or even Bronze Age, but it is possible that the Scottish submerged forest, of which the pre-Tardenoisien age is undoubted, represents the lowest submerged forest of the areas further south.

Now Dr. Pearsall tentatively correlates the Submerged Forest with the birch forest at the base of the Pennine peat, and suggests that its destruction coincided with the colder climate assumed for the Lower Turbarian. Dr Woodhead, however (*Journ. Bot*, Oct. 1924, p. 303), does not assume any increasing cold to account for the destruction of this forest. Further, if the Pennine forest lies above sand containing relics of a Tardenoisien industry, and the Submerged Forest lies below gravels of the same date, the two cannot be contemporaneous.

It is, of course, very desirable that correlation should be attempted, but, until Dr Pearsall can build on better and on sounder foundations than he has done, it seems a pity that the very beautiful and precise work done by Mr. Holmes, Mr. Buckley and Dr Woodhead should be obscured by such speculations

LAURANCE H. TONKS.

Manchester, December 12, 1924.

MR. TONKS raises some interesting points to which further reference seems to me desirable, in regard to my article on the ages of peat deposits That article refers to the peat horizons recognised by Lewis in Scotland and uses the names which Lewis adopted. It points out that these "roughly correspond" to Geikie's well-known climatic periods. Mr. Tonks appears to assume from this that I have accepted and argued from the whole of the implications of the Lewis-Geikie system. Nothing could be further from the truth. Mr. Tonks then apparently accuses me of declaring that Samuelsson has agreed with these implications. It is, in fact, evident from the paragraph in which my reference to Samuelsson occurs—that the points of agreement between Samuelsson and Lewis to which I refer are the nature of the Scotch peat succession, its widespread character and its possible relation to climate. My opinion that these are the main conclusions to be drawn from the work of Lewis remains unshaken. The article further refers to the "submerged forests round the English coasts" and not to those known in Scotland, to which Mr. Tonks refers at length. There appears to be no clear evidence that the English and Scotch submerged forests are of the same age although the suggestion Mr. Tonks makes is quite possible. Much of Mr. Tonks's letter is thus based on misinterpretations and misunderstandings.

One of the objects of the article was to indicate, so far as possible, that if one attempts to correlate the results of the British and Scandinavian peat investigations, then the results throw considerable doubt on what may be termed the climatic hypothesis of peat stratification. This result is actually obtained whether the age of the Scotch peats is estimated through the 40-50 ft. beaches, a doubtful method as Mr. Tonks shows, or through the 25 ft. beaches. In the latter

case, according to Lewis, the mosses in Southern Scotland lying on the 25 ft. beaches have a basal layer of shrub remains (largely birch) above which are peat layers chiefly composed of Eriophorum. This stratification agrees with that of the upper layers of the older mosses further inland. The wood layer *may* thus approximate to that of Lewis's Upper Forest layer, and since the 25 ft beaches are about Campignien age, the Upper Forest would be approximately Neolithic. On the climatic hypothesis, this might be held to suggest that the Neolithic period was relatively warm and dry in Scotland—agreeing on the whole with the Scandinavian conclusion Yet in the Pennines this period appears to have been one of forest destruction and peat development, which would, on the climatic hypothesis, require cold and moist conditions.

The whole point of these attempted correlations, so far as I am concerned, is that on whatever they are based, they result in throwing doubt on the hypothesis that peat stratification is, in Britain, an indication of climatic change The method employed in the original article results in the correlation of Lower Turbarian (presumably cold and moist) with the destruction of the Pennine Forest While this is better so far as Britain is concerned, it means on the climatic hypothesis that in Neolithic Britain conditions tended to be cold and moist, while in Scandinavia they were relatively warm and dry. The point of my article as expressed in the last two paragraphs remains just as clear if the Scottish peats are wholly ignored They represent, however, the chief British evidence for the climatic theory of peat succession, and hence the attempt was made to include them, though admittedly nothing but the establishment of cultural horizons can give an adequate basis for this correlation

W. H PEARSALL

Acid-base Titrations and Equilibria of Weak Bases and Acids.

IT has been supposed in the past that substances with feebly acidic or basic properties, say with K_a or K_b less than $2{\cdot}5 \times 10^{-9}$ in the case of N/20 dilution, are incapable [1] of estimation by acid-base titrations. I have recently succeeded in elaborating a technique by which this object can be attained: the main principles involved are set out below.

The titration of strong acids or bases in the presence of indicators depends on the steep (and maximal) gradient in the degree of acidity (hydrogen ion concentration, P_H) at the "end-point" in the neutralisation. Thus, with a fairly strong base the P_H during a titration is governed by the well-known mass-law approximation,[2]

$$p_{Kw} - p_H = \log \frac{1}{[\dot{O}H^-]} = \log \frac{1}{K_b} + \log \frac{[\text{Acid added}]}{[\text{Base remaining unneutralised}]}, \quad (1)$$

from which can be deduced the indicator with most suitable transition zone for the titration. An analogous equation holds for the titration of fairly strong acids.

Equation (1) rests on the assumption that all the acid added to the weak base goes to form a completely dissociated salt and that the free base is itself non-ionised. The first assumption is no longer true with a very weak base having a dissociation constant commensurate with that of water: a highly acid solution is formed, a large fraction of the added acid is uncombined with the base, and the effect of the acid on the solute is masked by its effect on the solvent, no end-point being shown when P_H is plotted against added acid. This difficulty has been overcome by a formula and method of approach already applied by the writer to amino-acids and polypeptides [3] From each value of "Acid added" is subtracted the amount present in the free state, which can be calculated from the equation

$$[H^+] = a[\text{free HCl}], \quad . \quad . \quad . \quad (2)$$

where a is known and $[H^+]$ is the quantity determined experimentally, and it is found that the formula so modified becomes strictly applicable to the very feeblest bases, and the corresponding modified formula equally applicable to acids. The *modus operandi* of the technique is to determine the volume of standard soda or hydrochloric acid required to titrate the solute over a given P_H range or to a given P_H end-point: for any given K_a or K_b value this is directly proportional to the amount of solute present With the simplified apparatus now available, such as the Cambridge Instrument Co.'s portable outfit and Mr S. W. Cole's hydrogen electrode, a complete electrometric P_H determination can be carried out within the space of several minutes

The theory has now been tested in detail in relation to some thirty acidic and basic groups The accuracy obtainable is found to be of the same order as that of an ordinary acid-base titration by the old-fashioned method. Thus the very feeble second basic group in arginine ($K = 1{\cdot}2 \times 10^{-12}$) may be estimated with an accuracy of at least 1 part in 100 in, say, M/20 solutions, while the P_H during the course of a titration may be predicted to within 0·02 P_H units, that is, with an accuracy comparable with that attaching to the experimental reading With mixtures of acids or bases of different strengths the corrected amounts of alkali (or hydrochloric acid) required to titrate over a given P_H range is the sum of the amounts for each acidic or basic group

Utilising this fact, I have been able to resolve a compound titration curve into its various components and estimate each of a number of acids and bases or ampholytes present simultaneously in a mixture, even when the respective K_a and K_b values are sufficiently close to cause partial overlapping of the individual titration curves In order to estimate a given substance, it is not essential to know the exact K_a or K_b values when once its P_H combination curve has been determined, and on this basis I have been able to make accurate determinations of proteins in solution. Details will shortly be published (Proc Roy. Soc., B.) Other applications have included investigations of the molecular weight and chemical constitution and dissociation constants of several bodies of biochemical interest, and the detection of chemical changes (*e.g.* the disproof of the theory of acid or base addition at peptide linkage in dipeptides) particularly those occurring during denaturation and enzyme hydrolysis.

An experimentally determined "correction for blank" has previously been arbitrarily used by Tague [4] for the action of soda on amino-acids, but without reference to the titration theory, mass law equation, K_a and K_b values, or prediction of titration curves.

In deducing differential expressions for buffer value, Van Slyke [5] (1922) independently made use of a formula which is similar to the present writer's, but in which no account is taken of the incomplete dissociation of the titrant. The effect of the latter on the accuracy of the formulæ is evident from the

[1] J. Chem. Soc., vol. 119, pp. 140, 156 (1921).
[2] Biochem. Z., vol. 78, p. 122 (1917).
[3] Proc. Roy Soc., B, vol. 95, pp. 440-484, 500-522 (1923-4), J. Chem. Soc., vol. 123, pp. 3294-3303 (1923).
[4] J. Amer. Chem. Soc., vol. 42, p. 173 (1920)
[5] J. Biol Chem., vol. 52, p. 525 (1922)

following values for the second basic dissociation "constant" of arginine calculated from the experimental P_H values.

P_H	$p_{K_2'}$ Harris's Formula.	Van Slyke's Formula.
3·14	11·90	11·89
2·52	11·90	11·88
1·84	11·90	11·75

It was shown[8] that for amino-acids, results sufficiently accurate for most purposes could be obtained if α in equation (2) were taken as 0·9 when concentrations less than N/10 were dealt with. As recently emphasised by Cohn, P_H determined electrically is a measure of hydrogen ion "activity" rather than "concentration". I have obtained results sufficiently accurate for analytical purposes by taking for α Noyes and McInnes'[8] figures for the activity of KCl of the same concentration as that of the total HCl (titrant) added at each stage in the titration. Similar conclusions have been reached in titrating weakly acidic groups with soda. For highly accurate theoretical purposes I have calculated values of α for use in the presence of weakly basic or acidic groups of amino-acids from Sorensen's very careful P_H determinations of glycine—HCl and —NaOH buffers. My theoretical investigations relate mainly the one acidic and one basic group in glycine, and the one acidic and two basic groups in arginine: it is intended to publish a detailed report in due course.

LESLIE J. HARRIS.

School of Biochemistry, Cambridge,
and Carrow Research Laboratory, Norwich,
December 16.

The Ages and Masses of the Stars.

IN his article on "The Ages and Masses of the Stars" (NATURE, December 6, 1924), Dr. J. H. Jeans, to account for the source of stellar radiation, considers the possibility of positive and negative charges falling together, annihilating each other, and passing away "in a blaze of glory," thus setting free enormous amounts of "sub-electronic" energy. Proceeding, he says, "Nothing in the suggestion appears to conflict with modern atomic physics" and gives his reasons.

This may be very true, since we have nothing to disprove such a theory; but to make an assumption of such a fundamental nature, and, as it seems to me, on insufficient grounds, is rather disconcerting to a conservative mind. It requires some imagination to think of an electron and a nucleus, the properties of which are so vastly different, as "cancelling" one another.

The author's one strong argument in favour of his theory is based on the loss of the mass of stars as obtained by Eddington (cf. NATURE, May 31, 1924). In support of his theory of the annihilation of matter, Jeans makes the highly contestable statement, that "we know of no normal process by which mass can escape except by radiation, whence we conclude that the diminution of mass is the equivalent of the energy radiated away." Objection to this can immediately be raised on the ground that we have direct evidence of a stellar body losing mass, in the case of the tails of comets. Moreover, it has been shown by Gouy (*Comptes rendus*, 157, 186, 1913) and Page (*Astrophys. Journal*, vol. lii. No. 2, September 1920) that, in the case of an atomic vibrator, the radiation pressure may very well exceed the gravitational attraction on the surface of our sun. It is, therefore, quite imaginable that the sun is losing mass from its surface in this way all the time. In a greater degree would this be the case on hotter stars, even though much more massive than the sun.

On the other hand, if we reject Jeans's hypothesis, we rob him of his nearly unlimited supply of energy; but could this not, in a small way, be compensated for by attributing to the stars a high degree of radioactivity, this source of energy, I take it, not having been included by the author in his computation of the "super-electronic" energy of the stars?

T. SCHUMANN.

Sloane Laboratory, Yale University,
New Haven, Conn., U.S.A.,
December 17.

THE merit I am inclined to claim for my hypothesis of sub-electronic energy is that this one simple hypothesis clears away a whole tangle of astronomical difficulties. The hypothesis may strike the physicist as unproved and unprovable, as it certainly is, but I think the following considerations will show that it ought not to be dismissed as fantastic.

A gram of every substance (except hydrogen) contains 3×10^{23} negative electrons and a corresponding quantity of positive electricity. Each gram of the sun's mass radiates 60 million ergs per annum, so that if sub-electronic energy is not drawn upon, each of these electric charges must fall through an average potential difference of 0·0012 volts. The fall for one year does not look big, but radiation for 10^9 years requires an average fall of 120,000 volts, representing a fall from infinity to only 10^{-13} cm. from a charge $\pm e$. The figure of 10^9 years is the absolute minimum that can be considered; evidence from the orbits of binaries and from the approximate equipartition of energy in stellar velocities calls rather insistently for 10^{13} or even 10^{14} years. Also giant stars radiate anything up to a thousand times as much per unit mass as our sun. It would be possible to find tolerably good reasons for replacing the above figure of 120,000 volts by 12×10^9 volts, and 10^{-13} cm. by 10^{-17} cm. If we have to contemplate positive and negative charges getting as near to one another as this, it would seem that they might as well go a bit farther. To my mind it is easier to imagine a few charges stumbling into one another than to imagine a whole lot falling through these enormous potential differences and then stopping.

Radioactive energy and energy of nuclear rearrangement can, of course, be covered by an argument of the same general type, except that we have to picture charges of the same sign starting at these infinitesimal distances from one another. There is nothing impossible in it, but neither, I claim, is there in the hypothesis of mutual annihilation. The inadequacy of the highest degree of radioactivity known to us has been pointed out by Lindemann and others, but it has to be conceded that substances of far higher radioactivity may exist in the stars.

A comet's tail can lose mass, and this loss of mass may be permanent, because the comet's own gravitational field is slight in comparison with the general field of the sun, but the conditions are different for a body of stellar mass. So soon as a particle expelled by radiation pressure loses or changes its period of vibration, it will fall back into the star. A cosmogony based on the conceptions suggested by Mr. Schumann would seem to me to create more difficulties than it removes, but others may think differently. Mr. Schumann's cosmogony would certainly fit in well with Prof. Lindemann's theory of the nature of spiral nebulæ.

J. H. JEANS.

[8] J. Amer. Chem. Soc., vol. 42, p. 239 (1920).

London Fog of January 11-12, 1925.

THE accompanying curve (Fig 1) indicates the variation in the quantity of suspended impurity in the air of Westminster during the recent fog. There was nothing very abnormal until the night of Saturday, January 10, when the suspended impurity, instead of gradually falling in the afternoon as it usually does, commenced to rise at about 5 P M , reaching about 2 milligrams per cubic metre by 9 P.M This level of impurity was maintained until midnight, when the normal fall occurred to a minimum of less than 0 5 milligram per cubic metre at 5-7 o'clock on Sunday morning. After this the impurity rose rapidly until it passed beyond the scale of the recording instrument at 3 o'clock on Sunday afternoon It remained at this abnormally high level, which was more than 6 5 milligrams per cubic metre—probably approaching 10—until 7 P.M , when a gradual fall commenced, which was maintained fairly steadily until 5 o'clock on Monday morning, when the impurity was a little more than 0·5 milligram The same rapid increase in impurity again began on Monday morning about 7 A M., reaching a maximum of a little less than 4 milligrams per cubic metre at noon This was maintained until 3 P M , when there was a rapid fall until 6 P M.

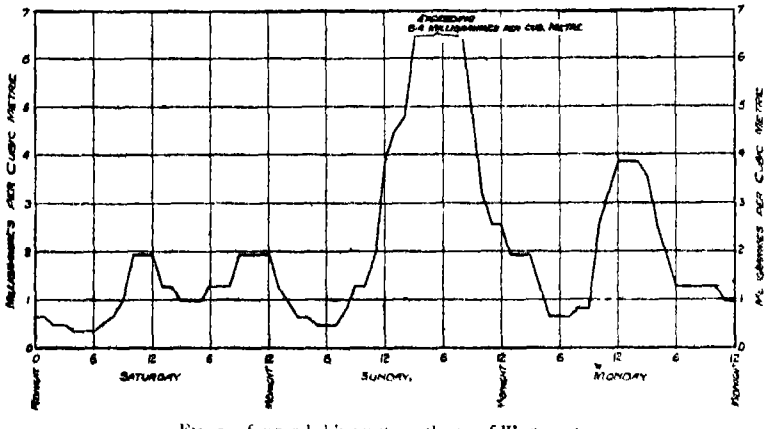


FIG. 1 Suspended impurity in the air of Westminster, Saturday, January 10 - Monday, January 12

There were one or two interesting points noticeable in this fog A dust record at 11 o'clock on Monday morning showed a reading of nearly 30,000 particles per c c. Unfortunately, no dust counts were available for the maximum period on Sunday, but there is usually a relation between the impurity recorded automatically by filtration and the dust count, indicating that about 8000 to 10,000 particles per cubic centimetre correspond to 1 milligram per cubic metre. On this basis there must have been something approaching 100,000 particles per cubic centimetre during the height of the fog on Sunday

Dust records taken 11 miles south-west of London, at Cheam, on Sunday afternoon, gave 15,000 to 16,000 soot particles per cubic centimetre, varying in diameter from 1·5 microns down, the average being about 0·7 to 0·8 micron. There were a few spherical particles and also a few drops of yellow oily-looking liquid, doubtless tar.

A dense record from 1000 cubic centimetres of air showed a number of dried-up stream beds blown out from the sides of the dust trace and formed by the water particles of the fog, and in the heads of these dried-up streams a large quantity of crystalline matter, in the form of skeletal crystals. The record itself was a thick, black line.

A microscope slide exposed from 4·37 to 4·55 P.M. and afterwards examined showed an extraordinarily rapid rate of settlement, the number of particles settling per square centimetre per minute at that time amounting to 80,000

A cover glass exposed from 5·4 to 5 24 P.M. in the same way showed a deposit at the rate of 75,000 particles per square centimetre per minute These particles were not water drops but solid matter and varied in size from about 1·5 microns down. There were a few small spheres Most of the particles were in the form of aggregates, but very few showed any indication of having been held in the water drops There were a few scattered particles, apparently crystalline in structure, and about 1·5 microns in diameter, which formed the centre of groups of smaller particles, suggesting the dried-up site of the impact of a drop The formation of aggregates and the entire absence of wind may be the cause of the exceptional rate of settlement, as the number settling was much greater than would be accounted for by the normal deposit of particles of a diameter of about 1 micron

On Monday morning the leaves and twigs in the hedges were covered with thick hoar frost which was brown in appearance A slide left out overnight was covered with ice which, when melted, gave a pool of black water, the roads were coated with a dark scum which, on the pools of water, showed as an iridescent oily-looking film It is very obvious that we were getting the London smoke in almost as great quantity as in a moderate London fog.

It would be of interest if any readers of NATURE living between south and west of London observed the phenomenon of this black deposit or discoloured ice crystals.

J S OWENS.
Advisory Committee on Atmospheric Pollution,
47 Victoria Street, Westminster, S W 1,
January 14.

The Discovery of Argon.

SIR J J. THOMSON'S reference to the discovery of argon, in his review in NATURE of December 6 of the life of Lord Rayleigh, will be read by chemists with surprise but without conviction, and though his comments upon chemistry must be received with the respect due to a late president of the Royal Society, they must also give rise to a certain amount of amusement. It is, however, with positive pain that many chemists have read Prof Armstrong's letter upon this subject published in NATURE of January 10. What does he mean by " behind the scenes " and " Ramsay and his ways " ?

As to the award of the medal, Prof. Armstrong omits to refer to Lord Rayleigh's speech on receiving it. This is printed in the Proceedings of the Chemical Society, from which I quote as follows " Lord Rayleigh, on receiving the medal, said that, in returning his thanks to the Society, he was somewhat embarrassed, because he felt that there ought to be another standing by his side . . . the credit for it must be

shared equally between Professor Ramsay and himself. In some quarters there had been a tendency to represent that antagonism existed between chemists and physicists in the matter, though such a thought had never entered his head. Professor Ramsay was a chemist by profession, while he himself had dabbled in chemistry from an early age, and had followed its development with very keen interest."

I returned from France to Ramsay's laboratory as an assistant in the autumn of 1894, and the first words he said to me, after shaking hands, were, "Well, it is a new gas." From April 1895 I was daily associated with him for years, and I have heard the early history of the discovery told many times. This I know for a fact: when Ramsay communicated his preliminary results to Lord Rayleigh, he placed them at his disposal, but Lord Rayleigh was equally willing to allow Ramsay to go forward with the work alone. I do not believe that either of these two great men ever felt the slightest regret that the discovery was shared. As a matter of fact, if neither of them had discovered argon their reputation would be scarcely less enduring.

Even during the preliminary stage, there were attempts to disturb the friendly relations between the two discoverers. A well-known chemist called on Ramsay, and after being shown everything, after the manner of Ramsay, went home and wrote to Lord Rayleigh, telling him that he must place no reliance on Ramsay's work Lord Rayleigh sent the letter on to Ramsay, with a brief comment, which Ramsay passed on to the author Later the "Suum cuique" letters in the *Chemical News* showed chemists that there were people in their ranks capable of the most unworthy actions

However, Ramsay, when alive, knew well when to meet and reply to criticism, and when to "Let them say" Ramsay, dead, will not suffer from attacks directed from "behind the scenes", but it may be hoped that the pages of NATURE will not be open to those who would discredit him in this manner

MORRIS W. TRAVERS.

147 Queen Victoria Street,
London, E C 4, January 12.

The Possibility of reproducing the Electrical Conditions of the Nitrogen Afterglow.

In a paper by Johnson and myself (Proc. Roy. Soc. A, vol 106, p 200) on the effect of argon on certain spectra, attention was directed to structural modifications induced in the CH band, λ4315, and in the CN bands, these being similar to changes observed by Strutt and Fowler (Proc. Roy Soc A, vol 86, p. 116), when these spectra were stimulated in the afterglow of nitrogen In a recent paper by Johnson (*Phil. Mag* vi, vol 48, p 1069) further evidence has been adduced for the similarity of the electrical conditions obtained in the afterglow to those existing when mild uncondensed discharges are passed through high-pressure argon In particular, an energy displacement in the first positive band spectrum, as developed in a tube containing a little nitrogen in the presence of high-pressure argon, was regarded as the analogue of the selection of three of the more refrangible heads in the several groups constituting the visible spectrum of the afterglow. The energy displacement was related quantitatively to the percentage of nitrogen in the nitrogen-argon mixture If the analogy can be sustained, it should follow that the intensity maximum in the several groups of the afterglow spectrum will be displaced a little towards the violet end as the afterglow is dying away (that is, as the percentage of activated molecules diminishes).

To test this, the spectrum of the afterglow has been photographed through a neutral wedge at two points about 7 inches apart in a glass tube, through which a stream of glowing nitrogen was pumped. Owing to the comparatively small light gathering power of the spectrograph, photographic exposures of 16 and 40 hours respectively were necessary, and even then the intensity was insufficient to permit of quantitative measurement of the plates. A close comparison, however, indicated no pronounced energy displacement.

Attempts have also been made to reproduce the β-group of the afterglow spectrum from discharge tubes containing nitrogen and argon, but no positive results have been obtained. Incidentally, I have examined the spectrum of the light from discharges through ammonia in high-pressure argon, in the hope of obtaining the spectrum of the afterglow when atomic nitrogen (arising from the destruction of the NH_3 molecule) returned to the molecular state. There was no evidence, however, of either the characteristic α or β groups occurring.

I have also excited the band spectrum of iodine in the presence of high-pressure argon, but did not observe the relative intensity changes which Strutt and Fowler record as characteristic of the development in the afterglow

It would appear, therefore, that while there remain several points of resemblance between the electrical conditions of the afterglow and those existing when a mild discharge is passed through high-pressure argon, there are many specific effects of the former which are incapable of reproduction in the latter case

W H. B. CAMERON.

The Queen's University, Belfast,
December 22, 1924.

Science and the Community.

THE article under this title in the issue of NATURE of January 3 refers to the small part played by scientific men in public affairs and in business life. I think that the explanation of this is simple. One man has a fixed amount of daily energy. If he makes a great effort in one direction his effort in another direction is correspondingly weak; and so, in general, one man cannot excel in more than one direction.

Now a successful business man, or, even more so, a politician, owes his success almost entirely to his powers of divining the wishes and thoughts of that strange creature—man. A man of science, however, is dealing with an inanimate world which cannot be influenced by tact, persuasive powers, or individuality. Consequently, in general, those personal qualities and mental characteristics which lead a man to success in business have no relationship at all to those which lead to success in scientific work. In fact, the inexactitudes and tactful misrepresentations characteristic of the business and political world are excessively distasteful to a man trained in the clear honesty and rigour of scientific thought, and put him at a positive disadvantage compared to his commercial fellow-man when engaged upon delicate negotiations of any sort.

In general, a man who has worked for years studying physics and higher mathematics will be much less tactful and much less persuasive, and will probably be a worse judge of character, than a man who has spent an equally strenuous number of years in persuading people to buy something which they do not really need. GEOFFREY MARTIN.

Rosherville Court, Burch Road,
Gravesend, January 5.

The Propagation of Wireless Waves of Short Wave-length round the World.

By Dr J A. FLEMING, F.R.S.

QUITE the most important of the pronouncements of the past year in connexion with wireless telegraphy were the two addresses given by Senatore Marconi to the Royal Society of Arts, London, in July and December, and also a paper by Sir Joseph Larmor, in NATURE of November 1, and the *Philosophical Magazine* for December last, on the theory of wireless transmission round the world Senatore Marconi gave details in July of his remarkable achievements with electric waves of relatively short wave-length, and in December of his discovery that waves of only 30 metres in length, or about 100 ft, can be used for reliable communication by day as well as by night over any distance, even to the antipodes, although entire continents and mountain ranges intervene (see NATURE, September 6, p. 359, and December 27, p 939) In this most important advance, he has certainly priority of achievement, as he had in 1901, in long-wave transmission across the Atlantic. When in 1902 Senatore Marconi discovered the great difference in range between day and night transmission with long waves across the Atlantic, it at once became clear that wireless transmission involved not only the ether of space round the earth, but also that the atmosphere itself, and especially, its state as regards illumination by sunlight, had a great deal to do with the matter.

In the years that followed, radio engineers came to the conclusion that the best prescription for achieving regular commercial radiotelegraphy at all times of day and night over long world-distances was by increasing the wave-length and power. Hence between 1902 and 1922 the demand for long distance radiotelegraphy involved the erection of large high-power all-round stations with great aerials sending out electric waves 30,000 to 60,000 ft. in wave-length, and using power from 500 to 1500 horse-power or more. The latest example is the 1000-kilowatt British Government radio station now being erected at Rugby.

The inhabited land area of the world being chiefly confined to one-half of the terrestrial globe, and the useful long wave-lengths being included within somewhat narrow limits, it is clear there is not an unlimited possibility of putting up all-round super-power radio stations without risk of interference.

Accordingly, so far back as 1916, Senatore Marconi began to consider the alternative of exploring the utility of the other extremity of the wireless spectrum or gamut of wave-lengths, and using waves more nearly 100 to 300 ft in wave-length projected as a beam by skeleton parabolic mirrors of vertical wires. It was well understood that when using such mirrors, the wave-length employed must be less than the aperture and height of the mirror, and constructive difficulties placed a limit on the mirror dimensions. Hence for beam projection short wave-lengths were essential. In 1916, experiments were conducted by Marconi in Italy with such short-wave beam radiotelegraphy for war purposes; and later in England, with the able assistance of Mr. C. S. Franklin, important results were obtained in radiotelephony by 15-metre waves between London and Birmingham. The achievements between 1916 and 1922 described in published papers by Senatore Marconi and Mr. Franklin in 1922, amply demonstrated the practical value of these short waves of 100-metre wave-length or less. In 1923, a series of tests by Marconi and his assistants on his yacht over long world-distances showed that communication could be established by these waves from Poldhu to Australia, but that the 100-metre wave had a markedly greater range by night than by day

In October of 1924, Marconi discovered that the daylight range increased very rapidly as the wave-length was reduced from 100 to 32 metres, or say from 300 to 100 ft , and that perfect communication could be established for all hours of the day and night between England and Australia by the 32-metre wave when using only 10 or 12 kilowatts (say 15 h.p.) in the transmitter

Apart altogether from the immense practical importance of this discovery, it raises scientific questions of high interest as to the mechanism by which these waves travel round the world It is now quite clear that normal wave diffraction is not sufficient The signal strengths at large world-distances are thousands of times greater than they could be by mere diffraction. It is generally agreed that the effect must be due in some way to ionisation of the high-level atmosphere, which descends to a lower level during the day-time. Although many theories have been put forward, the important paper by Sir Joseph Larmor, above mentioned, throws fresh light on the subject. When an electric wave passes through ionised air it sets the ions in vibration If the ions collide at once with gas molecules, energy is dissipated and the wave is weakened

If the mean free path of the ion is long (say 10 times) compared with the distance the ion is moved by the wave in the periodic time of the wave, then there will not be much dissipation of energy but the effective dielectric constant of the medium will be reduced and the wave velocity increased.

Larmor shows that at a certain height in the atmosphere, there is a region in which this accelerated and slightly dissipated wave energy can travel, and that a comparatively small ionic density will be effective. His equations show that the increase in wave speed depends on the ionic density and the square of the wave-length, and the modulus of absorption of the wave energy on the product of the ionic density and wave-length.

The increase in speed of the upper part of the wave front causes the wireless ray to curve round the earth, and Larmor specifies the conditions which must be fulfilled for the required curvature to be produced.

It appears, then, that for a given ionic density the long waves are more absorbed than the short, but the long waves have more energy at starting. Each wireless ray has its own proper path in the ionised air in travelling from the transmitter to any receiver. The shorter waves travel at a higher level in the atmosphere where the ionic density is greater and more constant, and this compensates for the smaller wave-length in giving the required ray curvature and makes them less affected by day and night variations. The

longer waves travel chiefly in a region in which the ionic density varies very much between day and night and are thus less absorbed by night.

In a general way, therefore, the theory fits in with facts, but there are an immense number of well-known wireless wave effects which will require consideration and discussion before we can say we can account for them all on any theory Meanwhile, the practical consequences of the discovery of the properties of this 32-metre wave are very great

Is there, for example, any justification for creating new high-power all-round radio stations by which the communication is so to speak, bellowed over the world on 20,000-metre waves, when on the beam system perhaps a dozen stations could be erected for the same capital and annual working cost, which would whisper their message on 32-metre waves along limited paths, taking up much less room in the ether? Time, and perhaps expensive experience, will show whether the all-round high-power station is necessary. In any event, the short-wave system has the enormous advantage that the receiving appliances used in connexion with it are vastly more immune from atmospheric disturbances and render all-day and all-night intercommunication possible over long distances, even up to the antipodes.

The Oldest Fossil Fishes.

By Sir ARTHUR SMITH WOODWARD, F.R.S.

IT has long been known that the fishes of the Downtonian age--the earliest fishes of which we have any real knowledge—are very different from those which appeared in later times and persist in part to the present day. Prof Johan Kiær, of the University of Christiania, discovered fossil fishes in the rocks of this period in southern Norway a few years ago, and the first part of his memoir describing them has recently been issued [1] Prof Kiær's remarkable specimens add greatly to our knowledge of these fishes, and some of his conclusions are so unexpected that they are of extreme interest to both zoologists and geologists



FIG. 1.—*Aceraspis robustus*, Kiær Neatly complete specimen, nat size The foremost part of the head is incomplete. From "The Downtonian Fauna of Norway"

It appears that the Downtonian rocks of the Christiania region closely resemble those of Great Britain, and similarly contain the fishes in association with crustaceans and eurypterids in a good state of preservation They are shallow water deposits, with frequent traces of ripple marks and sun cracks, and Prof. Kiær thinks they must have been formed in freshwater lakes on flood-plains Some of the fishes are familiar, such as the beautiful Cephalaspidian reproduced in Fig. 1, which differs little from Cephalaspis itself except in having two dorsal fins instead of the single one. All, indeed, belong to known groups, and all are as usual small, none being more than two decimetres in length. The most striking novelties are referable to the Anaspida—laterally compressed fusiform fishes which were first described by the late Dr. R. H. Traquair from the Downtonian rocks of southern Scotland—and Prof. Kiær begins by devoting attention to the three new genera which he finds among these

In the original Scottish specimens, Dr. Traquair was unable to make out any definite features in the head, and until he obtained examples with the heterocercal (or primitive unequal-lobed) tail, he felt uncertain as to which were the dorsal and ventral borders respectively. In the new Norwegian specimens Prof Kiær has been more fortunate in finding both the head and the tail well preserved, and it now appears that the Anaspida differ from all other known heterocercal fishes in having the tapering end of the body bent downwards instead of upwards (see Fig. 2). Dr. Traquair indeed described all his specimens upside down. We have for the first time among fishes a form of tail which is known among the extinct marine reptiles, the ichthyosaurs, mosasaurs, and certain Jurassic crocodiles. Prof Kiær, following Schmalhausen, supposes that this arrangement is correlated with the position of the centre of gravity of the fish.

The roof of the skull, which led to the discovery of the anomaly in the tail, is also very interesting. So far as it affords a clue to the underlying soft parts, it agrees with the cranial roof in the contemporary and allied cephalaspidians. As shown in Prof. Kiær's outline restorations (Fig. 3), the large orbits are distinct, not far apart, and each is surrounded by a hard rim. Between them is a plate pierced by a perforation doubtless for the pineal body; and immediately in front of this is a larger median perforation which may

[1] The Downtonian Fauna of Norway. I Anaspida, with a Geological Introduction By Johan Kiær *Vidensk Skrift. I, Mat.-naturv. Kl.* 1924, No. 6. Kristiania, 1924

be rightly interpreted as an unpaired narial opening. The small dermal plates are symmetrically arranged and nearly on the same pattern in the three genera, but there is a tendency towards fusion into fewer and larger plates as shown in the three successive sketches *a*, *b*, *c*. In side view (Fig. 2) the cleft of the mouth is now seen for the first time in Anaspida, and it is bordered with large plates, at least in the genus here restored. In upper view (Fig. 3) the cranial dermal plates pass gradually backwards into the scales of the body, but on the side (Fig. 2) the limit of the head region is marked by a conspicuous oblique row of gill openings.

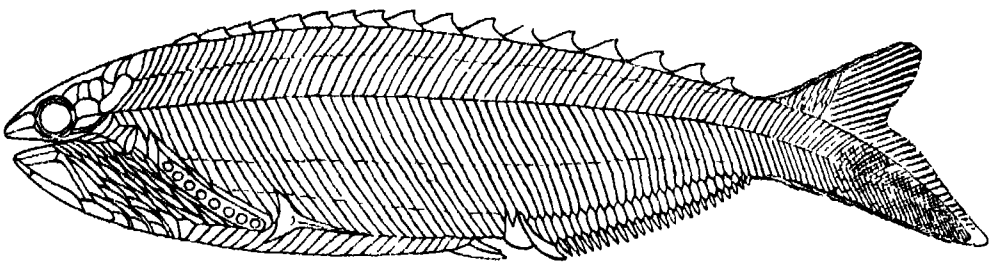


FIG. 2.—Reconstruction of *Rhyncholepis parvulus*, Kiær. × 2. From "The Downtonian Fauna of Norway."

No traces of paired fins have hitherto been observed in these lowly forerunners of the fishes, but Prof. Kiær finds in several specimens a small plate bounding the gill region behind, and a tapering spine which he considers to represent a pectoral fin (Fig. 2). Behind this spine there are apparently sometimes a few fin rays. Pelvic fins are entirely unrepresented. Enlarged scales only mark the cloacal opening and arm the front of the anal fin.

There are many more interesting details, for which it must suffice to refer to the memoir itself. Prof. Kiær not only describes them, but also concludes with an exhaustive discussion of the affinities of the Anaspida as they are now understood. Their anatomy, of course, can only be inferred from the hard dermal armature which is the sole part represented in the fossils. The single median nostril and the relative proportions of the parts of the brain suggest that the late Prof. E. D. Cope and others were right in regarding the earliest fishes as belonging to the same class as the existing lampreys and hag fishes. Even Prof. Kiær's discovery of evidence of ordinary jaws and rudiments of paired pectoral fins does not appear to him to invalidate this conclusion. The lampreys, which are obviously degenerate members of their race, may well have lost the structures in question since the early geological period to which the Norwegian fossils date back. The Downtonian genera indeed represent the heyday of the class, when the higher fishes were only just beginning to appear.

Prof. Kiær is led finally into even wider speculations as to the origin of the paired fins in fishes. He thinks the new discoveries indicate that a pair of pectoral fins appeared first, and then extended backwards as a paired fringe, of which eventually the pelvic fins were the sole persistent remnants. There may be differences of opinion on these and some other inferences, but Prof. Kiær's memoir is one of the most inspiring contributions to palæichthyology that has appeared in recent years, and we eagerly look forward to the promised continuation of it.

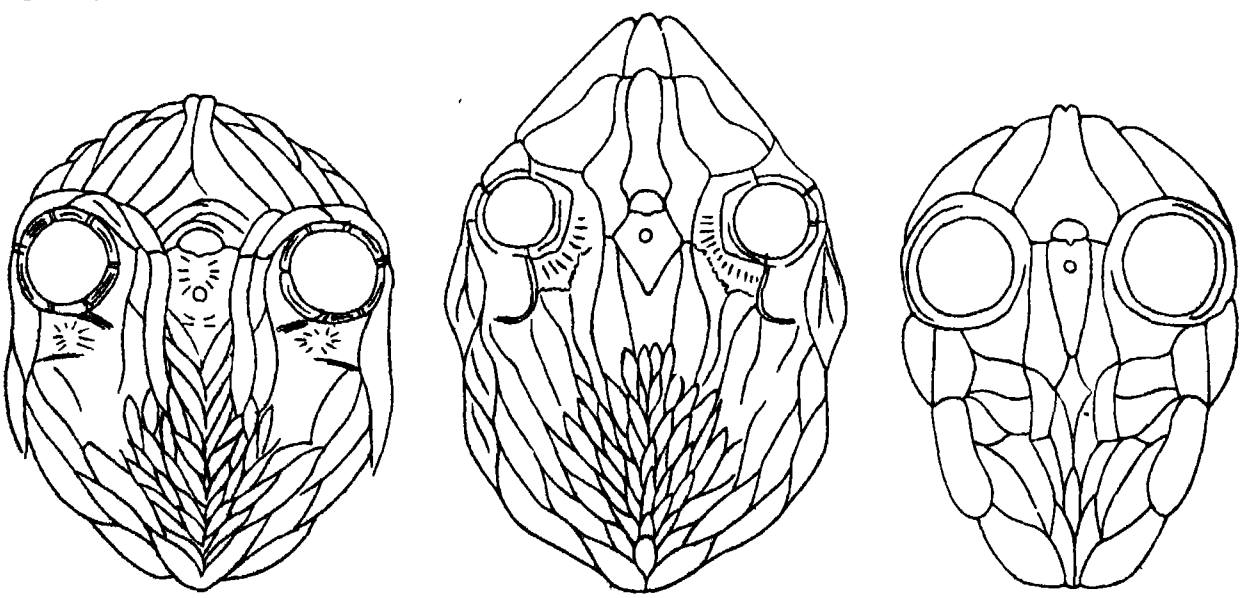


FIG. 3.—Cranial roof in schematic sketches of the Norwegian Anaspida. *a*, Pterolepis; *b*, Pharyngolepis; *c*, Rhyncholepis. From "The Downtonian Fauna of Norway."

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

4. KIRCHHOFF (1824–1887) AND BUNSEN (1811–1899).

IN the controversies that excited at one time a good deal of feeling with regard to the part played by different men of science in establishing the principles of spectrum analysis, some confusion was caused by the ambiguous meaning of the word "analysis." The term may apply to the separation of the spectrum into its constituent homogeneous radiations, or it may denote a method to identify the constituents of a chemical compound by the light it emits when raised to incandescence. To avoid the ambiguity, I introduced in 1882 the word "Spectroscopy," to indicate the physical side of this branch of science. With regard to the use of the prism as an instrument of chemical analysis, there can be little doubt that Kirchhoff and Bunsen first demonstrated its practical importance, though Wheatstone had clearly indicated its possibility.

I worked for one year with Kirchhoff at Heidelberg (1871–72). Those were not days of extensive and well-equipped laboratories. Next to Kirchhoff's private study, in the building which served as his residence, one room only was available for advanced work. Its chief occupant was Lippmann, who was working at his capillary electrometer. My table was by the side of his, and having placed myself entirely at Kirchhoff's disposal, he asked me to test an instrument he had devised for the study of metallic reflexion. Nothing came of it, partly because the instrument did not prove suitable for the accurate study of elliptic polarisation, and partly because my measurements were not very good owing to the astigmatism of my eyes, which had not at that time been recognised. The only other advanced student was Kamerlingh Onnes, who was experimenting with a pendulum designed to demonstrate the turn of the plane of vibration due to the rotation of the earth. He had to work in the lecture room next door. There was only one other room, and that was used for elementary exercises. One exercise was set aside for each week, and every student—about eight altogether—had a morning or afternoon assigned to him for carrying out the experiment. There was one weekly lecture in which the results were criticised and the succeeding exercise explained.

During my stay at Heidelberg, I was anxious to repeat an experiment I had previously performed on the spectrum of nitrogen. There was no glass-blower in Heidelberg and no means of obtaining a Geissler tube. Kirchhoff, to whom I appealed, advised me to consult Bunsen, who offered to let me use his laboratory, where I could find the necessary appliances. I had to confess that I was not sufficiently expert in glass-blowing to make the tube myself. He seemed rather amused, took me to a little room and spent the next half-hour at the blow-pipe. When the tube was ready, further difficulties arose. Bunsen gave me a very inefficient induction coil and insisted on my using a bichromate battery; but he would not allow the zinc plates to remain in the solution for more than two or three seconds, watching me all the time. I could not get a proper start and had to give up the experiment.

There are always innumerable stories about Bunsen illustrating his absent-mindedness and simplicity of character. Many of them will be found in Roscoe's "Reminiscences."

I attended Bunsen's elementary lecture course, which began at seven o'clock in the morning during the winter and at six in summer; but one had to be in the lecture theatre well in advance of the hour fixed, because the time was taken from a very erratic clock in this room. Whenever Bunsen was ready to start, he sent his assistant in to set the clock at six or seven as the case might be, beginning the lecture sometimes a quarter of an hour too early or too late by the real time.

There could be no greater contrast both in appearance and manner than that presented by the two men. Kirchhoff, sharp-featured and always correct and precise: Bunsen, with the appearance of a prosperous farmer, and a somewhat cynical but at the same time good-natured smile. New discoveries almost worried Kirchhoff. they amused Bunsen. The effect of light on selenium happened to be first published when I was at home on a holiday, and on returning to Heidelberg I mentioned it to Kirchhoff. His reply was: "I should not have believed that such a curious fact could have remained undiscovered until now." Kirchhoff's lectures were prepared with extreme care and delivered with precision. He is reported never to have missed one during the tenure of his professorship at Heidelberg, but the record was certainly broken on one occasion. "I regret to announce," he said on a certain Thursday at the conclusion of one of his lectures, "that circumstances prevent my meeting you to-morrow." The "circumstances" were that he was going to get married, and the honeymoon lasted from Friday till Monday, when he was at his desk again.

When both men had retired and were nearing the end of their lives—one at Berlin and the other at Heidelberg—I occasionally went to visit them. Kirchhoff's interests were confined to the days that were gone. He admired Maxwell for his work on the kinetic theories of gases. "He is a genius," he said, "but one has to check his calculations before one can accept them." He admired Lord Kelvin for his vortex theory of matter. "I like it," he remarked, "because it excludes everything else," and he added with a sigh: "If only it could explain gravitation." Bunsen liked to talk about new ideas. "Tell me all about the experiments of Hertz," was his first remark on one occasion; and in spite of his almost complete deafness, he had a way of understanding when the subject interested him.

It may be worth while to record the scepticism of Bunsen with regard to the chemical identity of diamond and carbon. He considered the evidence to be insufficient, depending in great part on a single reaction of the gas produced in the combustion of the two bodies. A more convincing test was the demonstration that equal weights of the two bodies produced equal weights of the products of combustion; but all depended here on the accuracy of the measurement, which probably was not very great. My information came from Sir Henry Roscoe, who repeatedly alluded to it in conversation. Engaged at the Cavendish

[1] Continued from p. 89.

laboratory on the spectrum of oxygen, I took the opportunity of placing a diamond inside a platinum spiral in an oxygen vacuum, and raising the spiral to a red heat by means of an electric current. The characteristic spectrum of an oxygen compound of carbon at once appeared, leaving no doubt as to the nature of diamond.

The examination for the doctor's degree at Heidelberg in those days was a purely oral one. The candidate was, in addition, supposed to send in a dissertation, but if this was not ready at the time of the *viva voce*, his degree was conferred on the latter alone, subject to the condition that he deposited a sum of money, which, so far as I recollect, amounted to 10*l*. This was returned if the dissertation was sent in and approved within one year. Three subjects had to be chosen, for example, physics, mathematics, and chemistry, of which one formed the principal and took up an hour. For the two others, half an hour was considered to be sufficient. The candidate, when ready, gave notice to the proper authority, and was in due course summoned to present himself on a certain day at seven or eight o'clock in the evening No account was taken of attendances or period of study Kirchhoff had the reputation of being a very strict examiner. When at the beginning of the year which I intended to spend at Heidelberg, I asked him how far I was expected to know the more mathematical branches of the subject, the only answer I got was: "I shall examine you in physics." All professors of the faculty received a fee for being present at the examinations, and the faculty of philosophy included all branches of arts as well as of science: this naturally secured a good attendance.

During my visit to Konigsberger, the examiner in mathematics, he told me that Kirchhoff was very fond of asking questions about the potential. This reassured me, as I felt pretty safe in that subject, but it turned out that the examination was all on optics. The candidate sat at a long table, surrounded by about twelve severe-looking individuals, most of whom were perfectly ignorant of scientific subjects. As I had not passed the "Abiturienten Examen," which is the school-leaving test, I had to submit to an additional examination in Latin; but the examiner told me, during my visit to him, that he would pass me however badly I did, and indicated the particular book in Cæsar's "De Bello Gallico" out of which he would ask me to translate a passage. I have a vivid memory of the mournful shaking of heads that went round the table when I translated "frumentum" with "Korn," which in German means "rye," instead of with the proper word which is "Getreide." An hour's *viva voce* can, of course, cover a good deal of ground, for, as soon as the examiner is satisfied that the candidate can answer a question satisfactorily, he at once passes on to another. After the first hour, a quarter of an hour was spent on light refreshments consisting of wine and cakes, and then the examination in the two secondary subjects began. Finally, the candidate was asked to withdraw, and after a few minutes' interval the result was announced to him. If successful, he was summoned to present himself to the Pro-rector next day. The degree was actually conferred after he had delivered an oath in Latin promising many things, one being that he would not take a degree at another German university.

All through the examination it appeared to me that the examiners rather took the part of advocates of the candidates against the gallery of dummy professors who were paid to be present. When I got into a muddle with Kirchhoff over a question involving the wave surface and he had not spotted my mistake, he only said, "We both have been rather stupid over this," and then started another subject. When I could not answer one of Konigsberger's questions he said. "There is no need for you to know this; I only asked you on the chance." As a matter of fact, I did know it, but failed to recognise the German expression which he used.

While I was considering the subject of my promised dissertation, I happened to meet the chief librarian of the university, who expressed the hope that I would default, for the reason that the forfeited deposits became the property of the University Library, which depended on this form of revenue.

Obituary.

DR G. D. LIVEING, F.R.S

BY the death of Dr. George Downing Liveing shortly after his ninety-seventh birthday, the University of Cambridge has lost the last of that small band of men who some sixty years ago set on foot the movement which proved the foundation of the present science school in that University. He was the eldest son of Edward Liveing, of Nayland, Suffolk; entering at St. John's College, Cambridge, in 1847, he was classed as eleventh wrangler in 1850, and as the first among the six who took the Natural Sciences Tripos in 1851, the year of its creation. After a short period of work under Rammelsberg in Berlin, he became a fellow and lecturer at St. John's College in 1853. In 1860 he married Catherine, daughter of the Rev. R. Ingram, of Little Ellingham, Norfolk, and thus automatically vacated his College fellowship in accordance with the old University statutes; in the same year he became professor of chemistry in the Military College at Sandhurst, but continued to teach in the St. John's Laboratory.

The Rev James Cumming, F.R.S., occupied the chair of chemistry from 1815 to 1861, and Liveing, who had acted as deputy during the last two years of Prof. Cumming's life, was elected into the chair in the latter year. Liveing retired from the professorship in 1908; the University then conferred upon him the honorary degree of Sc.D. and appointed him an emeritus professor. He had been a professorial fellow of his College since 1880 and was elected into a fellowship again in 1908; in 1911 he became president of St John's College. For many years he held the responsible and confidential office of Chancellor's secretary, an honorary official whose duty consisted in keeping the Chancellor of the University informed on all material happenings. In addition he served for long as a Borough and County Justice of the Peace, and was punctilious in the performance of his magisterial duties.

On his return from Germany in 1852, Liveing conceived the idea of providing instruction in practical chemistry for the medical students; no chemical laboratory existed in the University and one was equipped in a cottage on the west side of Corn Exchange Street, the fittings being improvised and oil and spirit lamps being used in default of gas. St. John's shortly afterwards built a small laboratory for Liveing, and this he used until long after he became professor in 1861. By this latter date, and largely as a result of the insistence of such progressive spirits as Liveing, the University had decided to build science laboratories; but the University was poverty-stricken, and for this and other reasons the oldest part of the present chemical laboratory was not built on the site of the old Botanic Garden until 1888. The difficulties which Liveing had to surmount in inaugurating a chemical school in Cambridge would have disheartened a man of less determination. His stipend was 100*l* per annum, paid by the Government and subject to the deduction of Treasury fees amounting to four guineas. As he has himself said, men in those early days had to devote their means as well as their wits to the service of the University. Until his retirement in 1908, Liveing financed the chemical laboratory as a private venture, and he informed me that he declined to submit his accounts, when challenged in later years by the suggestion that he had been drawing a large revenue, because he was ashamed to disclose to his colleagues how large a sum he had thus contributed from his own resources.

Prof. Liveing lectured on heat as well as on chemistry, but in 1871 James Clerk Maxwell was appointed to the Cavendish professorship of experimental physics, a new chair established largely by the exercise of Liveing's influence. Maxwell commenced to deliver the lectures on heat in the chemical lecture-room in October 1871. Later, Liveing espoused the cause of other new subjects in Cambridge; thus, he housed the beginnings of the present flourishing school of agriculture in his own laboratory, and protected and encouraged it until it became independent under the auspices of the Drapers' Company. In a similar way he devoted his energies and money to the establishment of the Cavendish College, an institution for the accommodation of impecunious students. This enterprise soon stopped for lack of funds, and the building is now the Homerton Training College for teachers.

Prof. Liveing was elected into the Royal Society in 1878, and in 1901 received the Davy medal for his spectroscopic researches—"one of the most valuable contributions to this department of chemical physics yet made by British workers." He joined the Chemical Society in 1853, two years before Roscoe, and shortly after his first paper appeared—"On the transmutation of the elements"—in the "Cambridge Essays," first series, for 1855, this little note is characteristic in its breadth of knowledge, its elegance in phrasing, and its economy of words. A few short papers on geological and minor chemical subjects followed, and in 1878 began the great series of memoirs on spectroscopy in conjunction with the late Sir James Dewar, who had been appointed Jacksonian professor of natural philosophy in 1875. The close and intimate friendship which existed between Dewar and Liveing was very striking; both were men of strong personality, but no two men could have presented a greater contrast in outlook, tastes and all essential characteristics. Yet each held the other in profound esteem, and neither ever said a word in criticism of his colleague; without this absolute loyalty, the happy collaboration of Liveing and Dewar could not have persisted for nearly fifty years.

Liveing's scientific eminence will repose on these joint spectroscopic papers; the skill which he displayed in the development of experimental methods and his infinite patience as an observer resulted in the collection of an enormous mass of accurate data concerning the spectra of the elements which is still in course of interpretation. During his latter years Dr. Liveing occupied himself with the publication in book form of these researches, the "Collected Papers on Spectroscopy," by Dewar and Liveing, was issued by the University Press in 1915. He read his last paper, entitled "The Recuperation of Energy in the Universe," before the Cambridge Philosophical Society on May 7, 1923, and was engaged on experimental work connected with certain ideas put forward in that paper until but a few weeks before his death.

It is difficult to appraise the achievements of one, just passed away, who had left his student days behind him before Frankland had stated the doctrine of valency and before Kekulé had devised the structural formulæ of the chemist. Liveing had been the personal friend of Dr. Whewell, the great Master of Trinity, W. H. Miller, the founder of our present system of crystallographic nomenclature, Adam Sedgwick, Sir Joseph Hooker, Michael Foster, Sir Gabriel Stokes, Sir George Airy, de Morgan and Charles Darwin, he had studied under Rammelsberg, Mitscherlich, Rose and Magnus. He once mentioned to me that he and Hooker, after some preliminary discussion, walked over to see Darwin for the purpose of hastening the publication of the "Origin of Species," which appeared in 1859. In his conversation, always sprightly and vivacious, he seemed often trying to translate our later knowledge into terms of the science of seventy years ago; as befitted one who belonged to the age when the collection of facts was the main objective of science, he was apprehensive as concerned the vast theoretical flights of modern physics and chemistry. Indeed, in his presidential address to Section B of the British Association in 1882, he expressed his distrust of the graphic formulæ of the organic chemist in terms which must be considered as vigorous, coming from one temperamentally so cautious in judgment and so moderate in expression. In talking with Liveing and hearing his statement of long obsolete chemical views,

> "Told, when the man was no more than a voice
> In the white winter of his age, to those
> With whom he dwelt, new faces, other minds,"

one began to realise the difference between the science of seventy years ago and that of to-day, and to speculate as to what our survivors seventy years hence will think of the science of the future. At the same time, and although an authority on the older chemical knowledge, Liveing always maintained an excellent appreciation of recent progress.

Like many other men of robust habit and great vitality, Liveing found it difficult to understand why

his contemporaries dropped out and passed away; declining health seemed to him as due to lack of resolution. He was an enthusiastic gardener, and when well past his ninetieth birthday engaged in all the manual toil incidental to the care of a large garden; after this work had become too heavy he took his exercise by walking, and, in fact, his last illness resulted from a collision with a cyclist. His memory of long-past events was remarkably clear until quite recently, but he sometimes forgot that others could not reach so far back into the past; a few months ago, whilst still in full mental vigour, he expressed surprise that I had not noticed the splendour of Donati's comet—in 1858.

Liveing shirked publicity and rarely spoke in the Senate House because, as he said, he feared being betrayed by provocation into expressing his views—formed with care and then held tenaciously—in terms which might flavour of exaggeration. But whilst others wrangled, Liveing worked, and he will be remembered as the last of that small band of Victorians who possessed themselves of a secluded and conservative institution with splendid traditions and passed it to their successors as a great modern University. A further reason for the rarity of his public utterances lay in the meticulous conscientiousness with which he carried out any duty undertaken; he attended every meeting of the numerous committees and councils of which he was a member, and the sheer labour which he devoted to the study of the questions concerned left him with little leisure or desire to influence others by the spoken word. But the counsels of one so wise, so prudent and so experienced were often sought and were always given in careful and measured terms. With the death of Prof. Liveing, the University has lost one of its most devoted servants, science has lost a pioneer whose early work will long serve as a starting-point for fresh advances, and a great gentleman has passed away.

W. J. POPE.

MR. W. WHITAKER, F.R.S.

THE death of William Whitaker on January 15, though for some weeks it had been clearly imminent, will be felt none the less as a deep personal bereavement by his many friends. The picturesque figure so familiar at the meetings of the British Association, the alertness in body and mind, even after fourscore years and more had laid their burden upon him, but, above all, the geniality which endeared him to all he met, will long be remembered. As a geologist he was a pioneer in the elucidation of the Tertiary strata and the superficial deposits of the south and south-east of England, second only to Prestwick in that branch of the science.

Born in London on May 4, 1836, Whitaker was educated at St. Albans Grammar School and University College, London. At the age of twenty-one he was appointed to the Geological Survey, and continued in that service until 1896. His work lay almost wholly in the London Basin and in the neighbouring counties. The original one-inch geological maps were largely the work of his hands, but he was indefatigable also in collecting records of artificial sections, wells, boreholes, and the other openings which abound in and around London. His labours culminated in the production of the Geological Survey Memoirs on "The London Basin," "The Geology of London and Part of the Thames Valley," and other smaller works. These volumes form standard works of reference and provide the basis on which much of the later literature is founded.

Among other records collected by Whitaker were those relating to the first deep borings that reached Palæozoic rocks under the Tertiary and Secondary strata of the south of England. By their aid he was enabled to trace variations in the development of these strata and to sketch broadly the form of the Palæozoic floor and the distribution of the rocks forming it. The possible existence and situation of concealed coal-fields had come up for consideration, and so long ago as 1889 he wrote "that Coal Measures are likely to occur somewhere along the line of the Thames Valley, or in neighbouring tracts. . . It is rash to attempt to foretell the future, but it seems to me that the day will come when coal will be worked in the south-east of England" ("Geology of London and Part of the Thames Valley," p. 46).

Whitaker retired from his official post at the age of sixty, in order to pursue economic geology. As a consulting geologist on sanitation generally, and on questions of water-supply especially, he attained a high reputation. But he still took pleasure in rendering service to the Geological Survey. A long series of memoirs on county water supplies from underground sources testifies to the diligence with which he collected records of wells and springs, and to the skill with which he interpreted them. This work he continued almost up to the last.

The history of the literature of geology occupied much of Whitaker's spare time. For some years he made "The Geological Record" his especial care, and he also compiled many lists of geological books and papers relating to counties, a task that might have proved tedious to one of less pronounced bibliographical tastes. Though much of his work was of this more or less statistical character, there stands to his credit a great record of original research. In addition to the many official memoirs of which he was author or part-author, his papers on Subaerial Denudation, on the Chesil Beach, and on Water Supply from the Chalk may be selected for mention. He was not given, however, to theorising and was never drawn into controversy.

The high esteem in which Whitaker was held by his fellow-workers is shown by the offices he was called upon to fill and the honours he received. Elected to the Geological Society in 1859, he served on the Council in 1873 and many years after, as president in 1898–1900, and as vice-president, 1901–2. In 1886 he was awarded the Murchison Medal, and in 1906 was the second recipient of the lately founded Prestwick Medal, a particularly appropriate recognition of his work in the field in which the founder of the medal had laboured. In 1923 he received the Wollaston Medal, the blue ribbon of British geology. He was elected to the Royal Society in 1887, and served on the Council in 1907–9. He presided over Section C of the British Association at Ipswich in 1895 and gave an illuminating address on the underground geology of that part of England. He was president also of the

Geologists' Association and of other societies. At the time of his death he was an honorary member of the Geologists' Association, of the Geological Societies of Liverpool, Manchester, and Yorkshire, of the Philosophical Society of York, of the Belgian Society of Geology, and correspondent of the Academy of Natural Science of Philadelphia

Whitaker made many a friend, but never an enemy. Indeed, it is impossible to suppose that with so kindly a nature he could speak an unkind word. To the younger generations of geologists he never failed to lay open his stores of knowledge, or to impart the enthusiasm with which he had himself been inspired. The attainment of the truth was the dominant motive with him, and it gave him as much pleasure that it should be attained by others as by himself Unselfishness, transparent honesty, and kindliness were the conspicuous features of his truly lovable character.

A. STRAHAN.

THE death on October 29 of Dr. Ernst Konig, of the famous dyeworks at Hochst-am-Main (formerly Meister, Lucius, and Bruning) at the early age of fifty-five, is recorded by the *Chemiker-Zeitung*. Konig's reputation rests securely upon his well-known researches in the field of photochemistry. Born at Flensburg in Schleswig, he graduated at the University of Leipzig, where for a very brief period he acted as assistant to Prof. Stohmann. In 1893 he entered the service of the dyeworks at Höchst, where he eventually attained a position of the highest responsibility At first he undertook the investigation of new coal-tar colours, but his chief interest lay in their application to photographic processes. In 1902 a photographic department of the works was formed under his direction, and two years later a new kind of three-colour collodion process, the *pinachrome* process, was invented. This was followed by the application of dyes to chromate-gelatin emulsions and the development of the *pinatype* process. He also devoted much attention to the production of various light-filters and desensitisers. One of the most important of his discoveries was that of the panchromatic plate. The problem of extending the region of sensitiveness of the emulsion beyond the yellow into the red and even far down into the infra-red region was solved by employing as sensitisers derivatives of quinoline, containing auxochromic groups in the benzene nucleus. König was also the author of numerous scientific papers and books on photographic subjects.

WE regret to announce the following deaths:

Mr. G Abbott, well known for his geological studies, and one of the founders of the South Eastern Union of Scientific Societies, on January 12, aged eighty.

Right Rev. L. C Casartelli, Roman Catholic Bishop of Salford, and formerly president of the Manchester Egyptian Association, of the Manchester Egyptian and Oriental Society, and of the Manchester Statistical Society, and the author of numerous papers in oriental journals and in the proceedings of the Manchester Statistical and Geographical Societies, on January 18, aged seventy-two

Dr. Clement Dukes, for thirty-seven years physician to Rugby School, and author of "Essentials of School Diet" and "School Health," on January 18, aged seventy-nine.

Dr J McT E. McTaggart, fellow of Trinity College, Cambridge, since 1891, and the author of "The Nature of Existence," on January 18, aged fifty-eight.

Dr Julius Morgenroth, a professor at the Robert Koch Institute for the study of infectious diseases in Berlin, and a former student and colleague of Paul Ehrlich, known for his work on immunity, on December 20, 1924, at the age of fifty-three.

Current Topics and Events.

GREAT encouragement for industrial research is contained in a notification just made to the chairman of the British Cotton Industry Research Association to the effect that 65,000*l* is to be received by the Association as an addition to its present income—most welcome aid towards the maintenance of the laboratories at the Shirley Institute, Didsbury The trustees of the Cotton Trade War Memorial Fund, acting on a recommendation from the Cotton Reconstruction Board, have decided, subject to the approval of the Board of Trade, to make this grant in instalments, 5000*l* for the year ending June 30, 1926, and 20,000*l* for each of the three years ending June 30, 1927, 1928, and 1929 Some four years ago the Cotton Reconstruction Board made a grant to the British Cotton Industry Research Association of 200,000*l*, a sum from which a large part of its income has ever since been derived, and the fact that the trustees have now decided to continue their help shows their great confidence in the ultimate benefits that will accrue to the cotton trade as the result of scientific research. Nothing could more strongly signalise the value of science to the industry than a gift such as this; and their appreciation of what they describe as "the good work being carried out by the Shirley Institute" is bound to encourage not only the staff there but industrial research workers throughout Great Britain. Further, they feel that this work should be made even more widely known to the trade and to the workpeople themselves, showing that the real importance of applied science is now being more fully realised. Thus the labours of chemists, physicists, botanists, and engineers on the fundamental problems presented by cotton are being justified.

THE Dominion of Canada, which extends in an irregular way on a 3000-mile base line, with a scattered population and cities widely separated, will benefit largely by radio communication In accordance with the agreement made between the Marconi Co. and the British Post Office, the Canadian Marconi Co. has begun to construct a "beam" station in Canada for communication with the stations which the Marconi Co is to erect in England. The transmitting station is being erected at Drummondville, 50 miles east of Montreal, where the main office is situated, and the receiving station is at Yamachiche, which is about the same distance from headquarters. Both sections

will be operated from Montreal by a "remote control" method. The work was begun last November, and although the temperature has often been 20° below zero and the workmen have to wear gauntlets to prevent frost-bite by accidentally touching metal, good progress has been made The transmitting aerials for communication to England are supported on five masts of steel lattice work and each is 300 ft. in height For communicating with Australia, five 250-ft masts are employed The power required for each station per beam is 150 horse-power and is obtained from a local power supply company. The power delivered to the anode of the valve required for each beam, however, is only about 25 horse-power. Both the sending and receiving stations which are to be erected in England will be operated by remote control from the Central Telegraph Office in London When the stations are completed, Canada will be brought into much closer contact with England and with Australia It has been agreed to fix the rates so as to attract the largest volume of traffic. It is hoped that in this way the trade between the Dominions will be fostered to the advantage of the British Empire as a whole.

SIR WILLIAM BRAGG, in his Friday evening discourse at the Royal Institution on January 16, dealt with the investigation of the properties of thin films by means of X-rays. The reactions of bodies must generally depend upon the nature and condition of the surfaces at which they meet, therefore the thin surface film is of great importance. It may differ in structure, composition, or other condition from the internal portions of the body, and the fine vision of the X-rays may well help in its investigation. The X-rays cannot take notice of a single film or layer, their especial power lies in the measurement of the spacing of a set of layers But the general laws of arrangement which are discovered in the crystal must be applicable to the thin film, and in some cases the thin film may be looked upon as one single layer of a crystal. Thus it has been possible to examine some elements of the structure of the fatty acids, alcohols, paraffins, and similar long-chain substances: to measure the thickness of the layers in which they lie, and to confirm with numerical amendments the previous measures of Langmuir, Hardy, Adam, Perrin, and other workers It is found also that the fatty structure of these substances is shared by many more solid crystals, in which also the molecules lie more or less across the flake: bound together by side-to-side ties which are stronger than those at the ends It is a general characteristic of crystalline structure, more particularly in the case of organic substances, that each molecule occurs in one or other of a small number of definite orientations: and that a molecule of one orientation binds together molecules of other orientations. The characteristics and probably the strength of the crystal depend upon the fact. It may explain the strength of the "black spot" of the soap film: the two layers of oleic acid on the two sides of the film are individually non-crystalline; but when they meet—the intermediate liquid being expelled—the full symmetry of the crystal can be realised, when all the orientations are present. The flaky substances are often greasy because of the toughness of each layer and the ease with which they slide on one another, pressure and rubbing tend to encourage the formation of the flakes in such substances as stearic acid

SIR OLIVER LODGE delivered the second of his series of talks on the ether under the auspices of the British Broadcasting Company at 2LO on January 20, taking as his title "Vibrations and Waves and what they signify" Sir Oliver stated that the ether is so uniform that it as difficult for us to discover it as a deep-sea fish would find it difficult to discover water All knowledge has to make its way slowly and painfully against a mass of prejudice and inertia nevertheless it is better to be slow in accepting the truth than to be ready to accept falsehood: a certain amount of opposition may be salutary Meanwhile our theories do not alter facts: the facts are there all the time, and are independent of what humanity thinks of them Some things we have learnt which were unknown to the ancients, but in time we too shall be ancients, and our descendants will wonder at the blindness and stupidity, even of our learned men We used to try to explain ether properties in terms of matter we now perceive that we must explain matter in terms of ether We now realise that the clue to the physical universe lies in electricity and magnetism We had thought that the way towards the light must lie in the open country of ordinary mechanics, we are now plunging into the wood—the forest of ether-dynamics But glimpses of illumination have been caught through the branches, and have heartened the younger generation of physicists with a great enthusiasm Those who have insight and intuition know that through this strangely unpromising country lies the road to reality.

ATTENTION is directed, in a leading article in a recent number of the *Scottish Naturalist* (December 1924), to a modern development in the protection of wild life in the United States of America. The sportsman has entered into competition with the naturalist in the race for the creation of animal sanctuaries. The reason is obvious The development of American legislation for the protection of wild animals shows very distinctly that a progressive disappearance of sporting mammals and birds has been proceeding for many years. The result is that, in the words of the Hon. John W Davis "Hunting is fast losing its character as one of the most democratic of sports. The really good shooting-grounds are rapidly being taken up by clubs too expensive to be patronised by the average sportsman Drainage of great marsh and swamp areas, the natural breeding- and feeding-grounds of wild fowl, has threatened these with extinction We must establish shooting-grounds so that the man of average means may enjoy the ancient, healthful, and democratic pastime of shooting, and *we must have the refuges if we are to continue to have the wild fowl.*" Accordingly a "Game Refuge Bill" has been introduced into Congress with the whole-

hearted support of the American Game Protective Association and of sportsmen generally. The combination of sportsmen and naturalists in an endeavour to protect wild life is a movement of great significance, for, as the *Scottish Naturalist* points out, "the sanctuary is the best solution of the problem of the preservation of the native fauna."

A REPORT on excavations at Ur by the Joint Expedition of the British Museum and the Museum of the University of Pennsylvania since November 1, when the season's work began, appeared in the *Times* of January 14. The main object of the work this year will be to discover whether the great ziggurat or tower was an isolated structure or formed part of a more considerable complex. Excavations to the north-west of the tower, between it and the enclosure wall, have brought to light living quarters and storerooms of the priests of the Persian period which overlie a courtyard laid out by Nabonidus. Beneath the latter was a range of buildings dating from the 16th century B.C., and beneath this again were the walls of shrines erected by the kings of Isin and Larsa (*c.* 1600 B.C.). Underneath this stratum was found the terrace wall of Ur-Ungur, the builder of the ziggurat. Inscribed nail-shaped cones of fired clay were found driven into the wall, this being the first indication ever found of the use of these objects. On the south-east side of the ziggurat a "Hall of Justice" has been brought to light, a structure originally a triple gateway, of which the back door had been blocked up by a later cross wall. Mud-brick chambers had been built alongside, in or on the ruins of the double wall in which the gate tower had originally stood. An inscription on a gate socket records the restoration of the fallen tower about 650 B.C. The original gate has yet to be discovered. It is known that it had been repaired by Ishme-dagan of Larsa by 2000 B.C.

AFTER an exhaustive inquiry by a commission which visited Europe, Japan resolved in 1921 to make the metric system of weights and measures compulsory throughout the Empire and took steps to secure a primary standard metre for the country. On the advice of Prof. Nagaoka, it was decided to obtain interference apparatus similar to that used by Benoit, Fabry, and Perot, who found that the red line emitted by cadmium vapour had the wave-length $0.64384696 \times 10^{-6}$ metre. According to a memorandum by Mr. F. Twyman on the measurement of standards of length in wave-lengths of light, the apparatus has been constructed by Messrs. Hilger, and in the course of his study of the literature on the subject of the metre, Mr. Twyman has noted how isolated the British are becoming in adhering to the yard as the standard of length, and how little is known about this standard to the degree of precision at present attainable. The British Empire, the United States, China, Paraguay, and Turkey appear to be the only countries in which the metric system is not now compulsory, and there appears every likelihood of China adopting the system in the near future.

KNUD RASMUSSEN, the Danish explorer, has been awarded the Charles P. Daly Gold Medal of the American Geographical Society for 1924 for his explorations in Greenland and northern North America. For twenty-five years he has studied the life of the Eskimo and explored northern lands. An account of his work and that of his assistants on the second *Thule* Expedition has appeared in the *Geographical Review* (vol. 8, 1919, pp. 116-125, 180-187). His latest expedition—the so-called fifth *Thule* Expedition—occupied three years, and the field of his work included the whole stretch of territory between Greenland and Siberia, as well as the study of the folklore, language, present distribution, migrations, and particularly the foci of migrations of all the known Eskimo tribes and families. The results will be issued in a series of volumes and maps. Among the most noteworthy of Rasmussen's earlier publications are "Greenland by the Polar Sea," "Eskimo Folk Tales," and "The People of the Polar North."

THE *Indian Antiquary*, which has been conducted by Sir Richard Temple as editor-proprietor for more than thirty years, has been transferred to the Royal Anthropological Institute and is being published by that body under the authority of its Council as from January 1. It will continue under the joint editorship of the present editors, Sir Richard Temple and Mr. S. M. Edwardes, with S. Krishnaswami Aivangar as Indian editor. In policy and scope the *Indian Antiquary* will remain unchanged, and will continue to deal with the history, ethnology, archæology, linguistics and folklore of India. The Council of the Royal Anthropological Institute has authorised the formation of an Indian Section of the Institute the function of which will be to afford a meeting-place for discussion among those in Great Britain who are interested in the anthropology, archæology and history of India, to correlate the results of research in these subjects, and also to co-operate with workers in India. The *Indian Antiquary* will serve as the official publication of this Section and in it the proceedings of the Section will appear.

PROF. BOHUSLAV BRAUNER, professor of chemistry in the Charles' (Bohemian) University at Prague, has been awarded the cross of a chevalier of the French Légion d'Honneur for his scientific work in chemistry.

DR. ALEXANDER WETMORE, of the U.S. Biological Survey, has been appointed superintendent of the National Zoological Park, Smithsonian Institution, Washington, in succession to Mr. N. Hollister, who died on November 3.

THE Tokyo correspondent of the *Times* announces that Mr. Rockefeller has made an unconditional gift of four million yen (400,000*l.* at par) to the Imperial University Library. It will be remembered that in the fire which followed the earthquake of September 1, 1923, the Library of some 700,000 volumes was destroyed.

WE have received the annual report and statement of accounts for 1923–24 of Livingstone College,

Leyton. The College was founded thirty-two years ago for the purpose of training missionaries in the elements of medicine, and 810 students have taken its courses of instruction during that period The deficit has been reduced by about 42*l.* during the year, but it still amounts to 1067*l.*, and further donations and subscriptions will be very welcome.

On Tuesday next, January 27, at a quarter past five, Dr H R. Hall will deliver the first of two lectures at the Royal Institution on the relations of the prehistoric Greek and ancient Egyptian civilisations, and on Thursday, at the same hour, Sir William Bragg will begin a course of four lectures on the properties and structures of quartz The Friday evening discourse on January 30 will be delivered by Prof J W Gregory on the mountain structure and geographical relations of South-eastern Asia, and on February 6 by Prof R W Chambers on the earliest recorded kings of the English.

The first presentation of the Rivers Memorial Medal for anthropological work in the field, founded by the Council of the Royal Anthropological Institute in memory of the late Dr W R Rivers, will be made at the anniversary meeting of the Institute to be held at the London School of Economics on January 27, at 8 30 As already announced, the first award of the medal has been made to Dr A C. Haddon, in recognition of his work in New Guinea, Torres Straits, and Borneo After the presentation, Prof. C G. Seligman, president of the Institute, will deliver his presidential address on "Some Little-known Tribes of the Southern Sudan"

In connexion with the recent celebration of the bicentenary of Sir Christopher Wren, the Royal Institute of British Architects published a book on Wren and his work (including St Paul's Cathedral), entitled "Sir Christopher Wren Memorial Volume. 1723–1923." The profits of the sale are devoted to the St. Paul's Preservation Fund. The sale of only one thousand copies of the five guineas edition would enable the Institute to hand over a sum of 2000 guineas, which would be acknowledged in the *Times* list in the name of each purchaser as a subscriber of two guineas. Orders, enclosing remittance, should be sent to the Librarian, R I B.A., 9 Conduit Street, London, W.1

A process of direct colour photography is recorded by A. Hoffmann (*Photographic Abstracts*, iv 139), who found that when photographing on a chloro-bromide transparency plate, objects reflected from the surface of a lake were rendered in their natural colours on prolonged development with pyrogallic acid. The angle of reflection proved to be the polarising angle The author found that by using a grainless emulsion of Valenta's formula and exposing with a black glass reflector in front of the lens, on development with 0·1 per cent. pyrogallic acid with relatively large proportions of ammonia and potassium bromide, images in very good natural colours were produced.

An investigator at the mines department testing station at Eskmeals, Cumberland, is shortly to be appointed, and applications for the post are invited. The duties of the person appointed will be to carry out, under the direction of the superintending testing officer, experimental work on problems arising in the testing of safety lamps (flame and electric), the analysis of mine air and mine dust, etc , and to assist the testing officer generally in carrying on the scientific work of the station Applicants must possess good scientific qualifications and have had experience in analytical and experimental work of this character. Forms of application, which must be returned not later than January 31, can be obtained from the Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W 1.

The Scientific Expeditionary Research Association dispatched the *St George* last April on a year's cruise to the Southern Pacific with the object of exploring many of the lesser-known islands and reporting on their natural history, ethnology, botany, marine life, etc An account of the work which has been accomplished was given in our issue of November 8, 1924, p. 681, by Mr J Hornell, the scientific director of the expedition It was intended to complete the cruise by studying the little-known islands south and east of Tahiti; but owing to unforeseeable circumstances, the funds are no longer available Unless about 9000*l.* can be raised at once, it will be necessary to recall the *St George* at what will be the most valuable and promising point of her voyage. An appeal has accordingly been issued, signed by ten members of the Advisory Council, representative of various branches of natural science, archæology, and so on, six of whom are fellows of the Royal Society. Subscriptions should be sent to the secretary of the Association at 50 Pall Mall, S W 1.

The work of the Smoke Abatement League of Great Britain, established in 1909, was dropped during the War and was not taken up again until 1923. Now the League is preparing a great campaign against the smoke nuisance and, with this object in view, is appealing for increased membership and support. We learn also that the valuable papers which were presented at the Manchester Smoke Abatement Conference held in November last under the auspices of the League, together with the discussions, are to be issued shortly in book form Particulars of the League's activities can be obtained from the honorary secretary, Mr. C. Elliott, 33 Blackfriars Street, Manchester.

A very interesting and instructive catalogue (pp. iv + 24) of industrial sands has recently been issued from the Westmoor Laboratory, Chatteris, by Mr. A L. Curtis, who for twenty years has specialised in supplying tested sands, and also clays and refractories, for technical and commercial use It will be a revelation to many that the particular requirements of manufacturers and contractors can be met by so many different kinds of natural and artificially-prepared sands The pamphlet describes more than fifty varieties used for widely different industrial purposes such as glass and pottery manufacture, sand-blast and other abrasive processes, moulding and casting, furnace lining, filtering, cement making

and testing, and less familiar applications in the soap and paint industries. Mr. Curtis has accumulated an enormous mass of data relating to the properties and uses of sands, and he undertakes to advise his clients on the problems that arise. Apart from his commercial enterprise, he is to be congratulated on issuing a pamphlet of unusual educational interest

THE fourth Annual Report of the Animal Breeding Research Department of the University of Edinburgh is a record of research work actively pursued in many directions under the guidance of the director, Dr. F A E Crew The Department is engaged on the problem of wool improvement in Welsh sheep, with special reference to its kemp content, with the object eventually of eliminating this undesirable element from the fleece Hybridisation experiments by crosses with Peruvian merino sheep are also being carried out with the object of improving British wools, and this has necessitated a detailed microbiological investigation of the fibres comprising the fleece of sheep Parallel investigations on the fecundity, fertility, sterility, and general physiology of fertilisation in sheep are in progress and promise results of great importance The list of twenty-one papers issued from the Department in the course of the nine months covered by the report is an eloquent witness to its widespread activities and to the value of the work being carried on there

WE are informed that Messrs. Gurney and Jackson, 33 Paternoster Row, have been appointed official publishers to the Faraday Society, and in future they will deal with all business relating to the sale of Transactions and separate Reports of General Discussions

WE have received from Messrs. Negretti and Zambra a specimen of an ingenious and simple pocket forecaster The instrument consists of three concentric circular discs, the largest of which is two inches in diameter. The instrument is set by first rotating the middle disc so as to bring an arrow on it into coincidence with the appropriate point on a wind direction scale engraved on the outer disc, and then rotating the inner disc so as to set an arrow over the appropriate reading of a barometer scale in inches graduated on the middle disc. The inner disc has three windows, one each for rising, steady, and falling barometer, fitting over a series of code letters A to Z. Through the appropriate window a code letter is read, and this letter selects one of 26 forecasts given on the back of the outer disc The instrument is ingeniously conceived, and can be recommended to those who desire to make the most of their barometer, with the proviso that no simple instrument can be expected to be infallible in dealing with so complex a phenomenon as the weather On the whole, it may be expected to give good results.

Our Astronomical Column.

WOLF'S COMET.—A Copenhagen telegram announces that Prof. Wolf succeeded in photographing this very faint comet again on January 13, at $17^h\ 58{\cdot}5^m$ G.M T (new), its position for 1925·0 being R A. $4^h\ 4^m\ 48{\cdot}0^s$, N. Decl 20° 14′ 54″ The Right Ascension was about $1^m\ 27^s$ less than Kahrstedt's ephemeris, the Decl 12′ greater The orbit elements therefore need considerable modification, but there has not yet been time to do this. The magnitude had declined from 16 to 17, so it is to be feared that the object will not be visible for very long

MINOR PLANETS.—*Astr Nachr*, No. 5341, contains a paper from the Berlin Recheninstitut describing the discovery of minor planets for the period July 1, 1923, to June 30, 1924 The number of discoveries is unusually large, 108, and shows that we are far from exhausting the zone Only 29 of these were sufficiently observed for trustworthy orbits to be calculated and to receive permanent numbers. The numbers assigned are 996 to 1024, so that the 1000 mark is now well passed No 1023 is named Thomana, the others are still unnamed The highest inclination among the new planets is 26° 58′ (No. 1019), the lowest 0° 41′ (No 996) The greatest eccentricity is 0 454 (No 1009), the smallest 0 009 (No. 1020) The periods range from 2 64 years (No 1019) to 6 25 years (No. 1004) A new plan for the provisional numeration of planets is adopted in the new year. The lettering will begin afresh each year. planets discovered in the first half of January will be denoted by AA, AB, AC . . . ; in the second half BA, BB, BC . ., in first half February CA, CB, CC . . , the first letter changing twice a month The system permits the insertion of planets afterwards detected on plates. The year must be prefixed to the letters, but in practice the last two digits of the year will suffice This system will put an end to the present diversity, three independent systems having been in vogue since the War.

STELLAR SPECTROPHOTOMETRY.—*Bull Astron* tome iv. fasc. iii contains an interesting research by M. Jules Baillaud on the distribution of energy in the spectra of stars of types A and B, also of Procyon (type F5). The observations were made at the observatory on the summit of the Pic du Midi (altitude 9384 feet). The curve for Procyon had a maximum at λ425, and resembled that of a black body at a temperature of 7000°. The curves for types A, B do not resemble those of a black body at any temperature. They fall off much more rapidly from their maximum. For type A this occurs in the neighbourhood of λ400, for type B it is at a wave-length even shorter than λ330, which is the limit to which the spectra were studied. The descent from this point is even more rapid than that indicated by Planck's formula for temperature 100,000°. The author concludes that the spectrum of stars of type B arises from the radiation of ionised atoms. He compares the continuous spectrum given by metallic vapours in an arc in vacuo, as observed by M. St. Procopiu.

α Cygni, though of type A, resembles β Orionis closely for the longer wave-lengths but not in the ultra-violet.

Two of the stars included here, γ Cassiopeiæ and α Cygni, were also studied by Plaskett. Baillaud's curve is much higher in the ultra-violet, perhaps owing to diminished atmospheric absorption. He determined the correction for this by observing the same star at different altitudes.

Research Items.

THE MOCK KING AT THE NEW YEAR IN EGYPT.—The December issue of *Ancient Egypt* has as a frontispiece a reproduction of the only illustration extant, fortunately preserved by Rifaud, showing the figure of the mock king degraded as *Abu Nerus*. The only account of this curious survival is given by Dr. Klunzinger in his book, "Upper Egypt. its People and its Products," published in 1878. On the tenth day of September, the first day of the Coptic solar year, each little town chooses from among its own members a king whose rule lasts through a festival of three days. During this period all official rule is abrogated and rigorous criminal investigations are held by the mock ruler, in which heavy penalties are inflicted even on the highest officials, and immense taxes are imposed. Both penalties and taxation are remitted for bakhshish. At the end of the three days the mock king is condemned to death and he (*i.e.* his clothes) is executed by burning The illustration shows that this festival took place at the date harvest Sir Flinders Petrie, in a note on the illustration and Klunzinger's account, refers to a title of the XIIth Dynasty, "New Year King of all the Nobles," which was borne by the highest nobles, and points out that this office, which the form of the title shows to have been annual, would indicate that the New Year King was a survival of an age much earlier than dynastic rule. It was a relic of an earlier kingship of prehistoric times and allowed a semblance of the ancient rule to the nobles of the old race, just as the king of the Saturnalia at Rome preserved among the enslaved aborigines a memory of their former liberty.

NEW CORBICULÆ FROM URUGUAY.—The genus Corbicula has a special interest for the student of post-Tertiary geology inasmuch as though now a southern form, it originally in both hemispheres ranged farther north, inhabiting Britain and Siberia in one, and attaining to Nebraska in the other. The American forms differ from the European in that the former have a slight palial sinus, which is wanting in the latter, and have been placed in a separate subgenus, Neocorbicula, by Fischer. Dall, however, has sought to revive Férussac's name of Cyanocyclas, which was only a synonym for Corbicula Mr. W. B Marshall in this respect has followed Dall when describing an interesting series of Corbiculæ from Uruguay (Proc U.S. Nat Mus, vol. lxvi art 15). Altogether eight new species are described and well illustrated, whilst a most useful list of the seventeen previously described American species, with the original references, is appended.

CINCHONA AND IPECACUANHA IN BURMA.—The Report of the Botanical Survey for India for 1923-24 contains further information as to the progress of the interesting experiment upon the planting of an experimental area (now at Mergui) in Burma with cinchona (see NATURE, April 21, 1923, p. 547, and January 5, 1924, p. 25). The conclusion of a brief description of progress is apparently "to confirm the optimism expressed earlier." With the more equable rainfall of Mergui, it appears that the period of nursery culture may be materially shortened, plants set out as quite small seedlings making such vigorous growth after rainfall that they have formed an area of young Cinchona already ahead of the older plants at the former station at Tavoy, now abandoned in favour of Mergui. So far the species to which this report refers is only *C. Ledgeriana*, but *C. succirubra* is also upon trial. Ipecacuanha is also under cultivation at Mergui, "where it is obviously much more at home than it ever can be in the Bengal plantations." Until now, however, no cropping has been attempted, but the policy of multiplication of stock continued.

BARK SCORCH OF WILLOWS.—A bark scorch of willows, caused by the fungus *Fusicladium salicis-perdum* Tub., has been known as a troublesome disease of willow rods for some time on the Continent. The disease was noted on the rods of willows grown for cutting in a market garden in Lanarkshire, and specimens were sent to the Edinburgh Botanic Garden for diagnosis, where they were examined by Mrs. N. L. Alcock (Transactions of the Royal Scottish Arboricultural Society, vol. xxxviii. part ii. October 1924, p. 128). The disease first appears as patches on the leaves resembling those of "scab" *Fusicladium dendriticum*, Fuckel, on apple leaves. The disease causes later on striking black patches on the bark giving the rod a piebald appearance, and it may also cause a die-back, and the young rod then turns black from the tip downwards. Little is known as to control, but probably a winter wash of copper sulphate would be useful Care should be taken when cutting out the rods to cut down to the stock, and not to leave long stubs Affected rods should be cut out and burnt.

PALÆOZOIC ALGÆ.—Interesting plants from the Old Red Sandstone of Scotland, showing clear indications of algal organisation, are described by the late Dr R. Kidston and Prof. W H Lang in the Transactions of the Royal Society of Edinburgh, vol 53, part iii. (No. 29), pp 603-614 *Cryptoxylon Forfarense* Kidston, described in 1897, is rediscussed in the light of a wider knowledge of Nematophyton, and as a result, it is transferred to the genus as *N Forfarense* Kidston, the pseudo-cellular structure of this species being no longer a bar to its transference to this genus. Two new species of Pachytheca are described, *P media* and *P. fasciculata* The genus includes a number of spherical forms about half a centimetre in diameter, which when split across show a central region or medulla surrounded by a radially striated cortex, composed of more or less evident tubes. In the newly described species, algal filaments can be clearly discerned on microscopic examination of favourable specimens, these run irregularly in the medullary region, and in groups of seven or more fine filaments through the cortical tubes, emerging from the ends of the tubes in a pencil-like group, in what is described as a peripheral "narrow clear zone" The authors suggest that where the algal organisation cannot be clearly made out, specific names should not be attached to specimens of this fossil, which are widely distributed and relatively abundant in certain formations in Britain They conclude that the relatively frequent association of Nematophyton with Pachytheca raises interesting problems as to the condition of life of these contemporaneous organisms, and that the mode of occurrence of both of them and the nature of the beds in which they occur will repay further work and co-operation on the part of palæo-botanists and geologists

SUNSPOTS AND TEMPERATURES.—In a recent pamphlet under the title "Sunspots and Temperature, 1916," Mr. A. H. Wallis, of Kimberley, criticises the conclusion of Nordman and Köppen that there is a tendency in the tropics towards low temperatures at times of numerous sunspots, on the ground that the relationship is not invariably valid and is based on the discussion of smoothed means. He suggests for further investigation a law that sudden rises in the daily sunspot number are frequently associated with

rises of maximum temperature. He apparently has not had access to the variation curves for 25 regions of the earth's surface from 1820 to 1910 prepared by J. Mielke, or to the 97 correlation coefficients worked out by G T. Walker; or he would realise that with a coefficient of only −0 2 or −0 3 in the tropics between the annual temperature and sunspot number, a perfect correspondence cannot be expected Also a negative coefficient in annual means might be perfectly consistent with a positive coefficient over short periods such as a day When, therefore, Mr Wallis claims to find in the course of a single year 199 daily agreements of sign in the departures of spots and maximum temperatures and 155 disagreements, he does not upset existing beliefs, neither does he provide much support for belief in a parallel relationship by an agreement of only 56 2 per cent of cases—his 79·4 per cent appears to be in error. Also during the year in question, his tables appear to contain 27 occasions on which there was an increase of 24 or more between the sunspot number of one day and the next, and in only 16 of these was there a contemporary rise of temperature All attempts to throw light on this interesting subject are welcome, but a further examination must be made before an addition to our knowledge can be claimed.

Investigations of Atmospherics.—All the various irregular noises which are heard in radiophones are classed together as "atmospherics" In long-distance working they are specially objectionable As a large amount of research work, the results of which are not readily obtainable, has been done on the subject, the paper by Dr R L Smith-Rose published in the January number of *World Power* will prove useful to many. The connexion between these noises and neighbouring thunderstorms was discovered at the end of last century by means of a coherer, and use was made of it in France, the owners of vineyards being warned of the approach of thunderstorms During the War the forecasting of thunderstorms was of great value in aviation It has been shown recently that all important atmospherics have their origin in mountainous regions and are due to electrical discharges The range of a disturbance caused by a lightning flash is usually world wide, and there are always sufficient lightning flashes occurring in some part or other of the world to account for all the noises heard in a radiophone. The energy radiated is only a small fraction of the energy required for the local disturbance, and hence radio experts find it difficult to imagine that anything except a lightning flash could produce the observed effects. They also think that the disturbances travelling through the ether must have a high frequency The methods used to eliminate these disturbances are to utilise the phenomena of directional reception, the beneficial effects being apparently more pronounced the shorter the wave-lengths used by the station

Theodolite Observations without Field Illumination.—Difficulties are often experienced, especially by workers in remote regions, in obtaining suitable illumination of the field when observing stars with the theodolite An ingenious attachment, which permits of observations being taken without any field illumination, is described by Mr E. A. Reeves in the *Geographical Journal* for December last A small semi-reflecting glass disc is placed in the focal plane of the telescope objective, taking the place of the ordinary diaphragm Another similar reflector, which is capable of horizontal and vertical adjustment, is screwed over the eye-lens of the eyepiece. When an image of the star is formed on the semi-silvered face of the diaphragm, the transmitted light passes through the eyepiece and emerges as a parallel beam on the eye-lens reflector. Part of this beam is reflected backward on to the diaphragm and again reflected into the eye Two images of the star are thus visible. These coincide only when the star is in the centre of the field. If the star is in any other position, the images part and move in opposite directions, the distance apart being double the error of pointing. The device can be readily fitted to, and conveniently used with, any theodolite if the object-glass is reasonably large. With a 5-in. theodolite, having a 1¼ in. aperture, coincidences can be made with 1st and 2nd magnitude and even smaller stars The device should be of use also in mines and other underground works where lamps have to be used as marks upon which to sight the theodolite

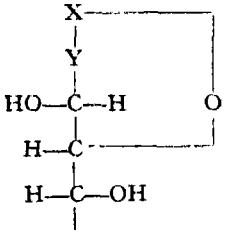
Physical Properties of Single Metallic Crystals.—Dr. P. W. Bridgman describes some physical properties of single crystals of zinc, cadmium, bismuth, antimony, tellurium, tin and tungsten in the Proceedings of the U.S. National Academy of Sciences for October 15, 1924 The properties listed include the elastic constants (which vary greatly with direction), linear compressibilities, linear thermal expansions, and electrical resistance The compressibility of cadmium could not be obtained, owing to the existence of two new polymorphic forms under pressure, the transitions taking place at about 3000 and 6000 kg./cm^2 (20° C.) The electrical resistance also changes slightly at the transition The properties of the new modifications are very similar to those of the ordinary modification Tellurium exhibits negative thermal expansion along the crystal axis The influence of pressure on the electrical resistance of antimony is anomalous; it tends to indicate that resistance is determined by something more specific than the distance apart of the atoms

Harmonic Tidal Constants.—In a paper entitled "Perturbations of Harmonic Tidal Constants" (Proc. Roy. Soc., A, 106, pp 513-526), Dr. A. T. Doodson, secretary of the Liverpool Tidal Institute, discusses some unusual features in the results of harmonic analysis of tidal observations at St. John (New Brunswick) and at Bombay. The principal lunar semidiurnal constituent M_2 at both stations shows three definite perturbations, one of these is of 19-year period, and arises from a failure of the ordinary method of allowing for the 19-yearly variation of M_2 (due to the varying longitude of the moon's node) The ordinary method assumes that two terms of closely similar period in the tide-generating potential will produce terms in M_2 of proportionate magnitude, and affected by the same phase lag. In actual fact this proves not to be the case, particularly at St. John, and the author states that, though the magnitude of the effect makes the explanation very difficult to believe, resonance is at present the only assignable cause St John is of course one of the stations where such a phenomenon is least improbable, since the very large tides in the Bay of Fundy are certainly due to resonance with a "sea seiche." But in addition there is another 19-year term in M_2 which can only be explained as due to frictional forces of considerable magnitude, depending on some higher power than the first (probably the second power) of the speed. This conclusion depends only on the forms of the expressions for the tidal elevations, and, while it is in general agreement with Dr. H. Jeffreys' calculation of frictional losses in the Bay of Fundy, it involves no numerical assumption as to the friction coefficient. Another perturbation of M_2 at St. John and at Bombay is a secular change of amplitude, ascribed to possible changes in the sand- and mud-banks near the ports.

Carbohydrate Metabolism.

THE breakdown of the carbohydrates found in the body, namely, glycogen and glucose, resulting in their final oxidation into carbon dioxide and water and the liberation of the energy stored in their molecules, takes place by stages, the details of which are still imperfectly known It appears probable that a compound of glucose with phosphoric acid forms an intermediate stage in the conversion of glycogen into glucose, while lactic and pyruvic acids are intermediate products in the conversion of the glucose into carbon dioxide. In the case of striped muscle, the process, as far as the formation of lactic acid, is reversible (Emden, Meyerhof, etc.). Now although the monosaccharides formed in the course of digestion are absorbed and converted into glycogen in the liver, in the reverse process only glucose is produced, suggesting that this sugar has some peculiarity of structure which enables the cells of the body to utilise it, in preference to the others; enzymes are probably concerned in the process, and one of the characteristics of their action is their specificity

Fresh light has been thrown on this subject by the work of Herring, Irvine and Macleod (*Biochem. Jour*, 1924, vol. 18, p. 1023), who have used insulin as a key to the structure which the sugar must possess if it is to be utilised The insulin was injected into mice, and the efficiency of various sugars and other closely related substances in curing the convulsions thus produced determined Glucose and mannose cured the animals completely, but fructose and galactose produced only a temporary improvement Maltose, however, was nearly as efficient as glucose, but somewhat slower in its action None of the other substances tried, including substituted reducing sugars and glucosidic compounds, had any effect Analysis of the results shows that the sugar must possess the following formula,



in which X or Y represents the reducing group The cells of the body are, therefore, only fitted to deal with a sugar of this general type, all other carbohydrates being converted into it by their appropriate enzymes, either directly or after synthesis into glycogen.

Working on quite different lines, Kay and Robison and their co-workers have investigated the properties and functions of the compounds of glucose with phosphoric acid (*Biochem. Jour.*, 1924, vol 18, pp. 1133, 1139, 1152, 1161). Two of these compounds are described, a hexosemonophosphate and a hexosediphosphate, the phosphoric acid being combined with a different group of the sugar in each case. Both compounds are probably present in the blood. An investigation of the distribution in the body of the ferments which act upon them shows that the diphosphate is hydrolysed by an enzyme present chiefly in muscle and blood, while the monophosphate is acted on by an enzyme which can be extracted from bone and ossifying cartilage. In fact, it is suggested that the latter compound is the form in which phosphorus is supplied to the bone in ossification. The injection of insulin increases the amount of the organic phosphoric esters in the blood and muscles, and it is extremely probable that it is the hexosephosphates which are thus affected In this case the fall in the blood sugar after insulin may be connected with the formation of these esters, since it appears that the sugar disappearing is not all oxidised, nor is it converted into fat (*v.* Burn and Dale, *Jour Physiol*, 1924, vol 59, p 164). The formation of a phosphoric ester would, however, be probably only a step in the reversible reaction, glycogen $\rightleftarrows$ glucose The actual direction in which the reaction proceeds depends in all probability on the amount of glycogen in the body in the well-fed animal, the glycogen present is broken down, in the diabetic organism, the reverse process occurs and glycogen appears in the liver

The phosphorus for the synthesis of the ester comes in the first place from the inorganic phosphate of the blood, with the result that less is left available for excretion by the kidney in the urine Sokhey and Allan (*Biochem Jour.*, 1924, vol 18, p 1170), confirming other investigators, have found that dogs after large doses of insulin excrete less inorganic phosphate in the urine during a period of six hours or so the total output for the day is, however, definitely increased, suggesting that some of the newly formed esters are broken down later on The nitrogen excretion is raised simultaneously with the fall in inorganic phosphate. possibly some of the phosphorus required comes from organic compounds which also contain nitrogen Sugar *per os*, on the other hand, while diminishing the inorganic phosphorus of the blood and urine temporarily, does not cause any increased total output of this element in the 24 hours at the same time it lowers the nitrogen excretion by taking the place of some of the protein previously oxidised It appears then that, with excess of sugar in the blood, more of the esters are formed at the expense of the inorganic phosphorus, but that, although the subsequent oxidation is sufficient to reduce the nitrogen excretion by sparing the destruction of protein, it is not enough to raise appreciably the excretion of phosphorus in the urine; the sugar is probably oxidised directly without previous synthesis to glycogen Insulin, however, causes a great increase in the formation of the esters, the phosphorus coming both from inorganic phosphates and also from bodies which contain nitrogen as well as phosphorus in their molecules. The glucose necessary is obtained from that circulating in the body fluids, but in the normal animal an additional source is provided by the reserve glycogen of the liver and muscles, the breakdown of the latter would produce an excess of free phosphorus, which would appear in the urine.

A somewhat different reaction is to be expected from feeding sugar and injecting insulin: glucose alone will not raise the total metabolism to any appreciable extent, while insulin, under certain conditions, will do so by increasing the carbohydrate oxidised, without at the same time reducing the protein broken down: in the normal animal, a limit is probably set to the amount of carbohydrate catabolised at any moment by the amount of insulin available It seems justifiable to draw the general conclusion that insulin acts by assisting the reversible reaction glycogen $\rightleftarrows$ phosphoric ester $\rightleftarrows$ glucose, by causing the production of the ester; the direction in which the reaction proceeds thereafter depends on the amounts of the various interacting substances present at the moment.

Nature and Origin of Coco-Nut Pearls.[1]

By Dr. F. W. T. HUNGER.

IN the endosperm cavity of the seed of *Cocos nucifera* a local calcareous formation is sometimes found to occur, to which the name of "cocos-pearl" has been given, and which must be looked upon as a highly remarkable and very rare occurrence.[2] Such a cocos-pearl has usually the form of a pear, or egg, sometimes it is almost spherical and has a smooth surface, as a rule of a milky-white colour. Its chemical composition corresponds somewhat to that of the oyster-pearl, from which it differs in appearance, however, by the lack of the pearly sheen.

Rumphius was the first to describe this calcareous formation as "calappites,"[3] and for more than a century after him nothing was heard of this condition, until at the meeting of the Boston Society of Natural History on February 1, 1860,[4] Mr. Fred. T. Bush presented a specimen of this cocos-pearl for chemical and microscopical examination. The research was entrusted to Dr. Bacon, who submitted his report on the subject at the meeting of the same Society on May 16, 1860.[5]

In 1866, Dr. Riedel, ex-Resident of Menado, reported having found a pearl in a coco-nut he opened.[6] This was the first report by an eye-witness who had actually seen such a thing, apart from the many stories told by natives about it.

Contrary to the statement of Bush to the effect that cocos-pearls "are said to be found free within the cavity of the coco-nut," Skeat[7] reported in 1900 that they are "usually, if not always, found in the open eye or orifice at the base of the cocoa-nut."

On my last voyage to the East Indies for purposes of study, I resolved to endeavour to find out something further about the cocos-pearl and if possible solve the problem of its formation. At the same time I realised the utter futility of going to look for cocos-pearls in the tropics, on account of their extremely rare occurrence. In proof of this it may be mentioned that on a coco-nut estate, where approximately three million nuts have been opened annually for years, no such pearl has ever been found, although stories about them have led to their existence being suspected.

I therefore directed my research to gathering as many authentic data as possible. On one of my voyages I met a native of British India who possessed a very fine cocos-pearl. According to his own account, he had seen with his own eyes this specimen inside an opened coco-nut which had been brought to him from Madras. He assured me that his pearl had been attached to the kernel of the coco-nut and exactly at the place where, in germination, the cotyledon forms a haustorium.

Later on I also met with an Arab on whose coco-nut plantation in South Borneo a coco-nut had been gathered which, on being opened, proved to contain a pearl attached to the inside of it. He had dislodged the pearl from the kernel of the nut with his own hand. In this case also the pearl had been attached at exactly the same place as in the case first mentioned.

These two corroborative declarations of eye-witnesses, who had both seen a cocos-pearl still attached inside an opened coco-nut, furnished me with a preliminary guiding-thread and led me to suppose that the spot which they indicated would probably be the normal point of attachment of such a cocos-pearl.

The normal germination process of the coco-nut begins by an enlargement of the embryo, whereby the cotyledon commences to grow inwards to an absorbing organ (haustorium), and thereby comes to protrude outside the endosperm and into the central cavity. Simultaneously with this, the plumule grows out and, breaking through the membranous operculum of the germinating pore, it pushes its way out through the hard shell.

Proceeding from the provisional determination of the place of attachment of the cocos-pearl, the following hypothesis could now be formed. Given that the germination, being in progress, is stopped by some cause or other, thus preventing the further development of the haustorium, it is conceivable that the haustorium in this state might become encrusted by the influence of the coco-nut milk, and that from this the completely petrified cocos-pearl would gradually be formed.

It was now necessary to find the reason for any such check in the process of germination and the accompanying solidification of the haustorium.

At the side where the coco-nut has been attached to the stalk, three thin spots, so-called germinating pores, or "eyes," can be seen in the hard inner shell of the fruit. As a rule one of these holes, the so-called "porus pervius," is closed by a membrane, whereas the two other, the so-called "pori cæci," are furnished with a hard tegument. In germination, the plumule pushes its way out through the porus pervius.

By way of exception there may be, instead of three, two germinating pores, namely, one porus pervius and one porus cæcus, and only very rarely will there be only a porus pervius with both pori cæci entirely absent. Nevertheless, a coco-nut of this description can germinate in the usual way. It is a different case, however, when there is not even a porus pervius, the base of the inner shell showing no germinating pore at all, as occurs in extremely rare cases. Such a coco-nut is known in the Malay language as a "kĕlapa boeta," or "klâpâ boentĕt" in Javanese, which signifies a "blind coco-nut."

As remarked above, a coco-nut without germinating pores is a very great rarity, for which reason they are regarded by the Mohammedans as sacred. The "kĕlapa boeta" is a talisman (*tjimat*) *par excellence*, and consequently it is difficult to obtain a specimen.

This meeting with the *kĕlapa boeta* furnished me with an example of the way in which normal germination is rendered impossible in Nature, and I did my utmost to procure some specimens. I finally succeeded in collecting eight unopened "blind" coco-nuts from the East Indian Archipelago. Most of the specimens were very old nuts; some, according to their owners, had been preserved for scores of years as family heirlooms.

The first four "boetas" which I opened produced nothing, but in the fifth I found a really beautiful pearl still attached to the kernel; the next two produced negative results again, and the eighth specimen I have kept unopened.

The nut which had contained the pearl had been gathered but a short time before, and the endosperm in it was quite normal, whereas in the other nuts the kernel was either very much dried up or had even partly become a mass of brown powder. The

[1] Reprinted, by kind permission of the author, from the Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam, vol. xxvi. Nos. 5 and 6.

[2] F. W. T. Hunger, "Cocos nucifera," 2nd ed. pp. 243-250, Pl. lxvii. (1920).

[3] E. Rumphius, "Herbarium Amboinense," vol. i. pp. 21-23 (1741); "D'Amboinsche Rariteitkamer," pp. 291-294 (1741).

[4] Proceedings of the Boston Soc. of Nat. Hist., vol. vii. p. 229 (1861).

[5] *Ibid.*, vol. vii. pp. 290-293 (1861).

[6] NATURE, vol. 36, p. 157 (June 16, 1887).

[7] W. W. Skeat, "Malay Magic, being an Introduction to the Folk-lore and Popular Religion of the Malay Peninsula," p. 196 (1900).

pearl was attached without the least trace of a stalk, being merely embedded in the endosperm, and was quite easy to remove from the kernel. It lay exactly at the base of the nut, just under the spot where the germinating pores ought to have been, and thus agreed completely with the indications as given above.

This discovery, in my opinion, warrants the inference that the cocos-pearl actually represents a calcified haustorium, which has been retained in the nut after the primary germination was checked, owing to the plumule not being able to get through the shell on account of the absence of the porus pervius. As the inner shell of the *kĕlapa boeta* remains hermetically closed, the newly formed haustorium becomes encrusted under the influence of the coco-nut milk with calcium salts, although it still remains unexplained why the cocos-pearl consists almost entirely of calcium carbonate, while neither the cocos-kernel nor the coco-nut milk contains this carbonate.

The belief that a *kĕlapa boeta* invariably contains a cocos-pearl was sufficiently disproved by my experience, that of seven specimens, only *one* such formation was found in a "blind" coco-nut. On the other hand, it is probable, in my opinion, that it will be principally (or exclusively?) the *kĕlapa boeta* that contains the cocos-pearl

Annual Meeting of the Mathematical Association.

THE annual meeting of the Mathematical Association was held at the London Day Training College on January 5 and 6. The report of the Council showed that the number of members has increased to 1019, in addition to about 500 associates connected with local branches.

The presidential address was delivered by Prof G. H. Hardy, the subject being "What is Geometry?" Prof. Hardy suggested that the time has come to consider what the subject taught in schools under the name of geometry really comprises It appears to be a mixture, partly an investigation of actual space-relations, based on intuition, partly a system of pure geometry, based on axioms But neither of these subjects is self-contained. Even the so-called projective geometry is not true projective geometry but is based on ideas of geometrical magnitude While recognising that the early teaching of geometry must be a compromise, and that the Association has done very good work in improving it, he thought that an effort might now be made to introduce into schools a more logical study of modern systems of pure geometry

Prof H. Levy gave an address on "The Mathematical Laboratory; its Scope and Function." He said that mathematics is not merely the handmaid of science Mathematical methods based on logical proof are not sufficient for modern needs the methods must be developed so as to meet the requirements of technology—of aeronautics, of biology, of industry He gave an account of the work done at the mathematical laboratory of the Imperial College of Science and Technology, S. Kensington The work, fundamentally, is experimental Any instruments available may be used, and the traditional restriction to rule and compasses is abolished Absolute accuracy is not regarded as essential, and graphical methods, giving results within about 0·5 per cent, are found to be sufficient. The problems to be solved are engineers' problems, not the mathematician's conception of engineers' problems. Differential equations are solved by approximation, by differentiation, etc., and their mathematical treatment in the lecture-room is followed by graphical treatment in the laboratory. The calculation of infinite series, and their differentiation, gives ideas of convergence and divergence of series, and a good deal that is of value can be derived from cases in which series obtained by graphical methods give incorrect numerical results in consequence of the series being divergent. Importance is attached to the study of cases in which different problems lead to the same mathematical equation. In the discussion on the paper, it was suggested that in a school the cost of equipment of a mathematical laboratory might be prohibitive; but Prof. Levy pointed out that, as great accuracy is not essential, second-hand instruments are usually quite good enough.

A discussion on the teaching of arithmetic in schools was opened by Prof J E. A. Steggall, who suggested that more attention might be given to the study of the properties of numbers, and that, in the earlier stages, children might concentrate on the study of some particular table, such as the table of measures of length The discussion raised some interesting points as to method, and questions as to the psychology of the pupil Prof Steggall, in replying, expressed his disapproval of the teaching of anything that could not be understood.

There was some discussion of the recent report (of the Association) on "The Teaching of Geometry in Schools" Prof. M J M. Hill dealt with various methods of arriving at the properties of parallel lines.

Mr A Buxton communicated a note on the treatment of a certain problem in optics by means of Bessel functions.

Dr. H B. Heywood contributed a thoughtful paper on the reform of university mathematics. In foreign universities, courses are given in subjects of which students in Great Britain have practically no knowledge The whole of our mathematical teaching in universities, even more than in schools, is dominated by examination requirements, and no reform is possible until the examination system is modified. Some suggestions that Dr Heywood made were that it is not necessary to examine over the whole field, but that an intensive study of some part should be allowed, that theses, followed by oral examination, should be encouraged, that more importance should be attached to reports by teachers, and that over the whole range the study should be less academic There is no border-line between mathematics and physics, and there is no need for physics to be made fictitious when it becomes a subject for mathematical treatment The extent of ground common to mathematics and physics should be investigated The decision as to the content of a mathematical course must be made on the basis of vitality, and this requires a purposeful study of the whole domain of mathematics, to see what portions are alive and growing Such a study would show what reforms are needed In the discussion, Prof. E. W Hobson agreed that reform must work downwards from the universities, but he was inclined to dissent, at any rate as regards Cambridge, from the view that the universities are more dominated than the schools by examination requirements Prof. Hardy stated that he considered reform to be impossible without destruction, and said he would like to begin by destroying the mathematical tripos.

During the luncheon interval, on the second day, there was a very interesting exhibition of pieces of apparatus, designed by Mr. E. J Atkinson, by Mr. C. V. Durell, and by Mr. D. F Ferguson, for use in connexion with the teaching of mechanics.

University and Educational Intelligence.

CAMBRIDGE.—The Sedgwick Prize has been awarded to Mr. H Hamshaw Thomas, fellow of Downing College.

Mr. C. T. R Wilson, fellow of Sidney Sussex College, university reader in electrical meteorology, and observer in meteorological physics at the Solar Physics Observatory, has been elected to the Jacksonian professorship of natural philosophy

OXFORD.—It is expected that in the course of the present term, which began on January 19, much progress will be made with the final settlement of College Statutes, which are now before the Universities Commission

The Romanes Lecture for 1925 will be delivered by Sir William Bragg in the Sheldonian Theatre on Wednesday, May 20, at 5 30 P M Sir William's lecture will be on "The Crystalline State."

PROF ANDREAS VON ANTROPOFF, of the Technische Hochschule, Karlsruhe, has been offered the chair of physical chemistry at the Chemical Institute in the University of Bonn.

ACCORDING to a message from the Toronto correspondent of the *Times*, the will of the late Mr D A Dunlap includes bequests of 50,000*l* to Victoria University, one of the constituent colleges of the University of Toronto, and 20,000*l* to the University of Toronto for medical resources.

MR F J HARLOW has been appointed principal of the Wigan and District Mining and Technical College, in succession to Mr S. C Laws, who has become principal of the Northampton Polytechnic Institute, London Mr Harlow has been, for the past four years, principal of the Blackburn Municipal Technical College He is a B Sc (Physics, 1st class honours) of the University of London and an associate of the Royal College of Science, and he also holds the diploma (by research) of the Imperial College of Science and Technology

PROF H E ARMSTRONG, addressing the students of the Stoke-on-Trent evening schools on January 8, protested vigorously against the unpractical character of the teaching in English schools "School, in the main, is but the means of keeping children occupied and ignorant up to a certain age, there is no conscious logical method behind it" Hence it is that our commercial men and leaders of industry are ill-informed, and manual dexterity is going from us owing to our slavish use of machinery To prate of the value of the study of the humanities while we welter in ignorance of the world about us, and the public remains incapable of appreciating and using the vast achievement of scientific workers for its intellectual development, Prof Armstrong stigmatised as "pure Pecksniffery" If the Potteries are to be capable of meeting the coming competition of Germany, the type of teacher required is the enthusiast for "Beauty in its many forms, one of which, and the greatest, is Truth," with power to kindle the imagination of pupils and other teachers Thence will come capacity for producing work of beauty and value which will therefore attract The number of students enrolled for the current session in the Stoke-on-Trent evening schools reaches the respectable total of 5700, including more than a thousand in the Art Schools and 600 in the Central School of Science and Technology, which, by the way, is extending its pottery course, for students who have completed a secondary school curriculum, from three to four years. It has a separately organised research department, with a staff of eight investigators.

Early Science at the Royal Society.

January 25, 1664/5. In order to see, whether the compression of the air caused the extinction of fire, there was put a lamp into the condensing engine; and a great quantity of air being crowded into it, it was found, that the lamp burnt in that compressed air about 15 minutes, whereas in the uncompressed air in the same engine, it burnt not above 3 minutes.—It was ordered that at the next meeting an experiment should be made, of filling a vessel with smoke, to see, whether a candle put into it would burn as long therein, as it would do in the same air without smoke.

1671/2. Mr Oldenburg read a letter from Mr. Newton from Cambridge, of a way of preparing a fit metalline matter for reflecting concaves "I desire," he says, "that in your next letter you would inform me, for what time the Society continue their weekly meetings; because if they continue them for any time, I am purposing them, to be considered of and examined, an account of a philosophical discovery, which induced me to the making of [my] telescope, and I doubt not but will prove much more grateful than the communication of that instrument, being, in my judgment, the oddest, if not the most considerable detection, which hath hitherto been made in the operations of nature"

January 26, 1670/1. Mr Oldenburg produced some of the rock-salt lately digged up in Cheshire, mentioning that the workmen had bored three yards into it That an hot fire makes the salt crack and fly like bags of kelp That hot water dissolves it speedily, and cold slowly that being pulverised it is a very strange salt, and the brown, that is free from mixture full as sharp as the white.

January 27, 1663/4. Ordered—That the president move this day the Society to appoint a committee of physicians, who are fellows of the Society, constantly to consider, what is necessary to be prosecuted in anatomy and surgery—That the porter be allowed three pounds a year for his constant attendance, to be paid him quarterly

1669/70. Mr. Oldenburg read the paper concerning Cassini's pretended new method, geometrical and direct, of finding the apogees and excentricities of the motion of the planets, after which he moved, that it might be inquired into, whether the like method had not been already found out in England. Whereupon Mr Mercator, having considered this matter in private, produced a paper of his, which shewed, that this very thing was founded upon what Dr. Seth Ward, now lord bishop of Salisbury, had demonstrated in his "Astronomia geometrica" published in 1656. This paper was read, and being found to be the demonstration of this alleged invention of Cassini, printed as such in the French *Journal des Sçavans* of September 2, 1669, it was thought proper, that the narrative of the truth of this matter should be published in the *Philosophical Transactions*.

January 28, 1662/3. Mr Hooke made the experiment of shutting up in an oblong glass a burning lamp and a chick; and the lamp went out within two minutes, the chick remaining alive, and lively enough.—Mr. Matthew Wren gave an account of a carp kept a whole week in a cellar out of the water, and fed with moistened bread, wetting the gills of it once or twice a day Dr Croune was put in mind to make this experiment, as he had formerly promised.

1668/9. The copies of Mons. Huygen's theory of motion were delivered, one to Dr. Wren, and another to Mr. Colwall.

January 30, 1660/1. Being the day of fast and humiliation for the death of King Charles I. there was no meeting of the Society.

Societies and Academies.

LONDON.

Royal Society, January 15.—Sir Charles **Sherrington** and E G T **Liddell** Further observations on myotatic reflexes The myotatic reflex of the knee-extensor obtains after pre-collicular as well as after inter-collicular transection The reflex retains tonic character after exclusion of the otic labyrinths Stretch of the knee-flexors also yields a myotatic reflex, a main action of which is the depression by inhibition of the myotatic reflex of their antagonist, the knee-extensor The reflex relaxation of the knee-extensor thus obtained is not changed into contraction by administration of strychnine —A V **Hill**, C N H **Long**, and H **Lupton** Muscular exercise, lactic acid, and the supply and utilisation of oxygen An attempt is made to apply to the case of muscular exercise in man the principles discovered in the last seventeen years by the physical and chemical investigation of activity in the isolated frog's muscle Part I. summarises the investigations, especially such as refer to the recovery process by which lactic acid, liberated during exercise, is removed in the presence of oxygen afterwards In Part II. is described the method of estimating lactic acid in human blood Part III is a description of the lactic acid changes which occur in human blood, during and after exercise, with an account of their effect on the respiratory quotient Part IV describes methods of studying the respiratory exchanges in man, under the rapidly altering conditions which obtain at the beginning and end of exercise. Part V is an account of the recovery process, in which oxygen is used and the lactic acid produced during activity is restored as the glycogen from which it arose In Part VI a discussion is given of the "oxygen debt" existing at the end of exercise, and of the muscle as an "accumulator of energy" Part VII. describes the relation between the rate of oxygen intake and the intensity of exercise Considerably increased amounts of oxygen can be taken in when breathing gas mixtures rich in oxygen. In Part VIII curves are given relating the "oxygen requirement" to the severity of various types of exertion —A. P **Chattock**. The physics of incubation. Daily cooling appears to be unnecessary, but an improvement in the hatching of more than 11 per cent is indicated if the usual twice-a-day turning is increased to four times at equal intervals By means of specially designed hygrometers, values of the humidity under hens have been obtained, very little improvement resulted from raising the humidity in incubators to the hen's nest value (20 mm water-vapour pressure at the centre) On the principle that the water vapour and carbon dioxide which escape from the eggs during incubation must both leave the nest by the same paths, the ventilation in a hen's nest may be estimated The value obtained is equivalent to the passage through the nest of 3·2 cubic feet of air per hour per 50 eggs; and is several times smaller than the ventilating air flow in typical "hot air" and "tank" incubators.—J. F **Fulton**. (1) The influence of tension upon the electrical responses of muscle to repetitive stimuli. Simultaneous mechanical and electrical records of short, maximal, tetanic responses of intact skeletal muscle (gastrocnemius and sartorius; frog) have shown that the *size* of the successive electrical responses varies in isometric contraction with the tension developed, and in isotonic records with the work done Tension *per se* rather than length of fibre controls the size of the action current. The mechanism which determines the size of the action current probably also controls the energy liberation within the fibre (2) The relation between the durations of the isometric twitch and of the after-action of tetanus The end of the plateau of short tetanic responses is characterised by an "angle" similar to that of the twitch The duration of the after-action as measured from the beginning of the last electrical response of the tetanus to the "angle" is, in short tetani, invariably less than the duration of the twitch. The ratio of these two durations is approximately the same as that of the size of the corresponding action currents. The terminal "angle" of long tetani is less precise than in short, and is also less precise at high initial tensions than at low tensions These modifications of the "angle" may be taken as evidence of slight fatigue—a less prompt "neutralisation" of the activating ions (3) Some observations upon the electrical responses and shape of the isometric twitch of skeletal muscle. Isometric twitches of the intact gastrocnemius of frogs, when recorded with a myograph of high natural frequency, have a flat top which terminates with sufficient abruptness to form on the linear record a clearly defined "angle." Any factor tending to produce fatigue, obscures the "angle" From the shape of the isometric twitch it has been inferred that the "fundamental" process of contraction is rectangular in shape, the "angle" representing the point at which it ends, and the curve of relaxation representing the viscous return of the muscle to its resting shape.

PARIS.

Academy of Sciences, December 15 —M Guillaume Bigourdan in the chair —P **Villard** The construction of electro-magnets Comparison of results obtained with differently shaped pole pieces, one cylindrical the other conical —Ch **Depéret** The classification of the older Palæolithic from the historical and geological points of view The palæolithic strata known as the Chellean consists of deposits of two different ages One of these is older than the Chelles gravels, and for this the term pre-Chellean is proposed The difference of age is shown both by the fauna and by the worked implements —Ch. **Depéret**, Fabien **Arcelin**, and Lucien **Mayet** New discoveries in the prehistoric deposit of Solutré (Saône-et-Loire) Following up the discoveries of human remains made in 1923, excavations near the same spot have revealed two more complete skeletons of Cro-Magnon type The excavations of 1924 at Solutré have proved the existence, in regular superposition, of a series of levels containing graves, ranging from the Aurignacian epoch up to historic times.—Maurice **Lugeon** River erosion. Example of the Rio Uruguay.—C **Sauvageau**. The curious development of *Castagnea Zosteræ* —Paul **Montel**. Some special complex families —J **Haag** The combination of the results of observation —René **Thiry**: Parallel displacement in Weyl's geometry —B **Galerkin**: The stability of a plate uniformly compressed parallel to its surface, limited by two arcs of concentric circles and by two radii —P **Laffitte** The propagation of the explosive wave C Campbell has shown that if the diameter of the tube containing an explosive gas mixture increases suddenly, the explosive wave ceases to propagate itself, starting from the point of discontinuity Experiments described by the author made with two gas mixtures ($CS_2 + 3O_2$ and $2H_2 + O_2$) show that although the explosive wave ceases to be propagated, starting from the point where the diameter changes suddenly, it reforms in the second tube after a period of combustion —Léon and Eugène **Bloch**: The spark spectrum of iron in the Schumann region. The wave-lengths and intensities of 253 lines in the

region 1855 Å and 1505 Å are given: about half of these are new.—Alb. **Colson**: The displacement of the maximum of solubility and the existence of constant solubilities.—E. **Carrière** and E. **Vilon**: Experimental study of the action of sulphuric acid on calcium oxalate. After proof of the existence of an equilibrium, the influence of each of the variables, temperature, concentration of calcium oxalate and sulphuric acid, and excess of sulphuric acid was separately determined, the results being shown in the form of curves.—Claude **Fromageot**: Adsorption and cataphoresis.—P. **Lebeau** and P. **Marmasse**: The thermal fractionation of the gaseous products from the carbonisation of the structural constituents of bituminous coals. Fusain, durain, clairain, and vitrain from an English coal, and vitrain and durain from a French coal have been submitted to the method of fractional carbonisation described in an earlier paper (*Comptes rendus*, 177, p. 319). The results are shown graphically and analyses of the total gas obtained given. The composition of the gases obtained are very similar and they do not differ much from the gas obtained by the carbonisation of the original coal. The two vitrains, however, show a higher percentage of methane.—G. **Saurat**. The quaternary formation of Syrte minor.—Pierre **Lamare**: The presence of granites in the valleys of Baztan and Bertizarana (Haute-Bidassoa) and their tectonic significance.—G. **Mouret**: The geology of the Plateau of Aigurande and the dislocations of the neighbourhood of Neris (Allier).—Sabba **Stefanescu**: The presence of *Elephas planifrons* and of three mutations of *Elephas antiquus* in the geological layers of Roumania.—H. **Hérissey**: The presence of a glucoside in *Baillonia spicata* capable of being hydrolysed by emulsin, and the products of hydrolysis of this glucoside. The glucoside was not isolated, but from its hydrolysis by emulsin, *d*-glucose and a lactone, named baillonigenol, were isolated in a pure and crystallised condition.—P. **Freundler**: The conditions of the stabilisation of iodine in *L. flexicaulis*. The initial amount of iodine in these algæ may be preserved in three ways: increasing the saline concentration, heating in closed vessels at 110° C., or by complete desiccation at 105° C.—L. **Grigoraki**: Contribution to the study of Dermatophytes.—A. **Maige**: The evolution of amylogen excitability of the plastids in cells with starch reserves.—Maurice **Nicloux** and A. **Yovanovitch**: The fixation of chloroform by the central nervous system and the peripheral nerves. The method previously worked out for the determination of minute quantities (0·5 mgm. to 1 mgm.) of chloroform in blood and the tissues has been applied to the study of the amounts of chloroform fixed by the nerves after anæsthesia. The peripheral nerves, such as the central nervous system, fix the largest quantities of chloroform.—R. **Herpin**: The swarming and development of Eunice and Syllis.—Armand **Dehorne**. The histo-physiology of the intestinal cells of Ascaris of the horse and of the turtle.—Ch. **Pérard**: Researches on the destruction of the oocysts of Coccidia. The oocysts of *E. perforans* and *E. stiedæ* have been submitted to the actions of solution of various disinfectants, including formol, phenol, corrosive sublimate, and hypochlorites, and are not destroyed after 24 hours' exposure to these media, and in fact appear to develop better after such treatment. On the other hand, these organisms are very sensitive to drying or to heat and this is recommended for their destruction.—Henri **Stassano**: The mode of action of heat on the lactic ferments in the pasteurisation of milk. Three methods were tested: maintenance at 95° C. for two minutes, at 63° C. for 25 minutes, and in thin layers at 75° C. for 8 seconds. Some lactic ferments survive all three methods of pasteurisation, but the third method proved relatively the most efficient.—P. **Lemay** and L. **Jaloustre**: The comparative action of bismuth on staphylococcus, streptococcus, and the Coli bacillus. The staphylococcus is most sensitive to the action of bismuth salts.—H. **Labbé** and **Lavagna**: The action of acetoacetic acid on the nitrogen nutrition.—W. **Kopaczewski**: Surface tension and the cancer problem. It is proved by experiment that the development of cancer is accompanied by a diminution of the surface tension of the serum and blood plasma.—Jean **Saidman**. The absorption of ultra-violet rays by the skin and its therapeutical applications.—**Kohn-Abrest**: The index of toxicity and the utilisation of petrol in motor-cars. The ratio CO/CO_2 in the exhaust gases of a petrol motor is defined as the index of toxicity. Some determinations of this index are given, based on analyses of the exhaust gases of a motor-car working under different conditions.

Calcutta

Asiatic Society of Bengal, December 3.—C. **Dover**: Further notes on the Indian diplopterous wasps. The subject is discussed from the faunistic point of view, and is based on a study of the Vespidæ in the British Museum; it is an attempt to settle the systematic position of various Indian forms.—Satya Churn **Law**: Kālidāsa and the migration of birds, No. 2. The migratory Hansas and Raj-hansas in Kālidāsa's works.—H. **Beveridge**: On Tamerlane. A review of the information in our possession about "the terrible Vulcan of Samarcand".—Maulavi 'Abdu'l **Wali**: Notes on the archæological remains in Bengal. The antiquities dealt with are situated in Burdwan, Murshidabad, Midnapur, Narayanganj, Birbhum, Aurangabad and other places.—Hirendra Lal Sen **Gupta**. A short history of the Madhyamika philosophy.—Hari Krishna **Deb**. "Ant-gold" and the Kautilīya Arthasāstra. The story of the so-called gold-digging "ants," in the sandy regions of Dardistan, related by Herodotus and later writers, is referred to in a passage in the Kautilīya. Cunningham's conjecture that these "ants" were some kind of marmots is confirmed. Incidentally, it is suggested that the "griffins" alleged to guard the gold dug up by "ants" may have been some variety of ant-eaters.—Hari Krishna **Deb**: (1) The Kautilīya Arthasāstra on the three classes of invaders. Invaders are classified in the Kautilīya as *dharma-vijayinah*, *lobha-vijayinah* and *asura-vijayinah*. The pre-Asokan date of this classification being shown, the inference is that India was already familiar with the Assyrian (asura) mode of invasion.—(2) The Kautilīya Arthasāstra on forms of government. The Kautilīya presents us with a threefold classification of forms of government, here analysed, namely, *rājya*, *dvairājya* and *vairājya*, corresponding respectively to government by one, by two or by the multitude. The Kautilīya's discussions contain helpful hints for a reconstruction of pre-Mauryan political and constitutional history.—Chhote Lal **Jain**: A bibliography of literature relating to Jainism, mainly from 1907 to 1924.

Rome

Reale Accademia dei Lincei: Communications received during the vacation, 1924.—T. **Levi-Civita**: Exact determination of periodic irrotational waves in deep water.—E. **Carano**: Observations on the mechanism of division of the mother-cell of the embryo sac in apogamous plants.—Bonaparte **Colombo**: Study of the equations

$$\frac{\partial^2 z}{\partial x^2 \partial y} + \frac{\partial^2 z}{\partial x \partial y^2} = f(x, y, z, p, q, r, s, t)$$

and

$$\left(\frac{\partial}{\partial x} + \lambda_n \frac{\partial}{\partial y}\right)\left(\frac{\partial}{\partial x} + \lambda_{n-1} \frac{\partial}{\partial y}\right) \cdots \left(\frac{\partial}{\partial x} + \lambda_2 \frac{\partial}{\partial y}\right)\left(\frac{\partial z}{\partial x} + \lambda_1 \frac{\partial z}{\partial y}\right) = F(x, y).$$

—Francesco **Sbrana**: Certain integral equations.—Washington Del **Regno**: Photo-electric emission of selenium. No difference is detectable between the emission from selenium in the dark and in the light, the free electrons thus appearing to play no part in the phenomenon. The purely electronic character of the conductivity of selenium under the influence of light is upheld.—Bernardo **Oddo**: Diindylmethane.—Gaetano **Charrier** and Alessandro **Beretta**: Action of nitrosobenzene on *o*-nitroaniline. The product of this action is *o*-nitro-*p*′-nitrosodiphenylamine.—Gustavo **Cumin**. Geological notes on the Istrian mountain region. I. Soils.—Enrico **Fossa-Mancini**. Tertiary strata in the neighbourhood of Orosei (Eastern Sardinia).—Ugo **Panichi**. The specific gravity of minerals and crystallised chemical compounds.—G. **Micatovich**. Experiments confirming the statolytic theory.—A. **Spartà**: Contribution to the knowledge of larval development in *Uraleptus Maraldii*.—Risso.—Livia **Garofolini**. Development of the chromaffine system and appearance of the chromoreaction in *Triton cristatus*.—Luisa **Volterra**. Variability of pelagic Dafnias in Lakes Albano and Nemi: *Daphnia longispina*.—Ugo **Banderati**. Action of alcohols on the sensory-motor cortical centres of the dog.—Mario **Ercole**. Contribution to the knowledge of the rhythm of renal secretion.—Carlo **Mannella**: Action of strychnine on the survival of the central preparation.—Carlo **Petacci**. Action of ethyl alcohol on the survival of the central preparation.—Palmira **Tavolaro**. Direct action of strychnine and various alcohols on the central preparation.—Oliviero **Olivo**. Commencement of the functional capacity of the contractile tissues in the embryo of the hen, in relation to their structural and morphological differentiation. I.: Functional and morphological differentiation of the cardiac embryo.—Gabriella **Armellini-Conti** and Giuseppe **Armellini**: Investigations on the variation of the luminous intensity of the moon during the total eclipse of August 14, 1924. From the moment at which the moon entered the earth's shadow until the eclipse became total, the total luminous intensity of the moon varied approximately according to a parabolic law. When the moon, entirely in the penumbra, began to enter the umbra, the intensity was nine-tenths of that exhibited by the full moon, whilst the intensity of the totally-eclipsed moon was about one-fortieth of that of the full moon.—F. **Zambonini** and G. **Carobbi**. Contribution to the study of the isomorphous relationships between compounds of beryllium and those of magnesium. In compounds of simple structure, beryllium and magnesium are probably not isomorphogenic except in very special cases, but mixed crystals of the double nitrate of magnesium and lanthanum with that of beryllium and lanthanum containing so much as 18 per cent. of the latter are obtainable.—L. **Sabbatani**: Pharmacological investigations on iron. VI.: Colloidal ferrous sulphide prepared in the presence of sugar. A preparation has been obtained which is much less toxic than that made in the presence of gelatin and is fixed more exactly and immediately, and almost exclusively in the liver and spleen. Such preparations produce pharmacological effects only as the result of chemical changes, which are rapid and profound with colloids of high degrees of dispersivity and stability, but slow and slight if the degrees of dispersivity and stability are low.—B. **Longo**: Further results on the sowing of the wild fig.—A. **Russo**. Different constitutions of the two pure gametes in *Cryptochilum echini* Maupas, resulting from the analysis of the nuclear successions, and the prevalence of the globuliform micronucleus.—Francesco **Sbrana**: Levi-Civita's parallelism for a surface of ordinary space.—Umberto **Crudeli**: Stationary motions in electronic dynamics.—Enrico **Fermi**: Theory of collisions between atoms and electric corpuscles.—G. **Carobbi**. Double nitrates of metals of the cerium group with copper and with cadmium.—G. **Sani** and V. **Grilli**: Practical notes on the conservation and transformation of nitrogen in stable manure.—Angelo **Bianchi**: Bismuthinite from Crodo, Val d'Ossola, and the crystallographic constants of bismuthinite.—E. **Onorato**: Celestine from Caramanico.—Emanuele **Quercigh**. Celestite from Pietraperzia and from Trabonella (Caltanissetta).—Carmela **Ruiz**: Celestite from Racalmuto (Girgenti).—Roberto **Savelli**. Genetic theory on the "electric mutations" obtained by Alberto Piròvano.—Cesare **Artom**: The species of *Gambusia* acclimatised in Italy (*Gambusia holbrooki* Grd.) in relation to the stability of the character of the gonopodium.—Giulio **Cotronei**. Dimensions reached by *Petromyzon fluviatilis* and the phenomenon of contraction. With this animal, the percentages of the two sexes may be considered identical. The female is larger than the male, and the form living in Southern Europe attains smaller dimensions than that of the north.—Boldrino **Boldrini**. Certain biological reactions encountered in the blood serum of women during and after the lacteal decline. I. Demonstration of a precipitin of human milk serum.—Gaetano **Viale**: Variations of catalysis in the blood on high mountains.—Marcello **Boldrini**. Internal and external measures of certain long bones in man and in woman. I. Volume of the medullary cavity and the phenomena of circulation and respiration.—Oliviero **Olivo**. Commencement of the functional capacity of contractile tissues in the embryo of the chicken in relation to their structural and morphological differentiation. II. Functional and morphological differentiation of the myotome.

Official Publications Received.

Annual Report on the Working of the Museum Department during 1923-24. Pp. xi. (Malta: Government Printing Office.)

Memoirs of the Asiatic Society of Bengal. Vol. 8, No. 4. Plant and Animal Designs in the Mural Decoration of an Uriya Village, by Dr. N. Annandale; A Working Model of the Origin of the Ganges in a Temple in Ganjam, by Dr. N. Annandale, with Notes by Mahamahopadhyaya Haraprashad Shastri and Percy Brown. Pp. 289-250+6 plates. (Calcutta.) 4.8 rupees.

Union of South Africa. Journal of the Department of Agriculture, Vol. 9, No. 6, December. The Annual Report of the Department of Agriculture for the Year ended 30th June 1924. Pp. xxiii+409-618. (Pretoria: Government Printing and Stationery Office.) 6d.

Department of Agriculture, Trinidad and Tobago. Administration Report of the Director of Agriculture for the Year 1923. Pp. 19. (Port-of-Spain: Government Printing Office.) 8d.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 8, No. 1. On the Fauna of the Anthracolithic Limestone of the Omi-mura in the Western Part of Echigo. By Ichirô Hayasaka. Pp. 83+7 plates. (Tokyo and Sendai: Maruzen Co., Ltd.)

Empire Textile Conference. Official Report of Proceedings of Conference held at the British Empire Exhibition, Wembley Park, Whit-week 1924. Pp. v+267+100. (Manchester: The Textile Institute.) 5s.

United States Department of Agriculture. Department Bulletin No. 1217. Mixing Emulsified Mineral Lubricating Oils with Deep-well Waters and Lime sulphur Solutions. By W. W. Yothers and J. R. Winston. Pp. 6. (Washington: Government Printing Office.) 5 cents.

Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March 1924. (M.O. 287.) Pp. 61. (London: H.M. Stationery Office.) 1s. 6d. net.

Union of South Africa. Department of Mines and Industries. Geological Survey. Memoir No. 21 on Magmatic Nickel Deposits of the Bushveld Complex in the Rustenburg District, Transvaal. By Percy A. Wagner. Pp. 181+22 plates. (Pretoria: Government Printing and Stationery Office.) 7s. 6d.

Meddelanden från Statens Skogsförsöksanstalt. Häfte 21, Nr. 7: Grankottmätarna (*Eupithecia abietaria* och *Strobilata*) och deras Skadegörelse. Av Paul Spessivtseff. Pp. 295-310. Häfte 21, Nr. 8: Tragmagare-studier (Anobiiden-studien). Av Ivar Trägårdh. Pp. 311-338. Häfte 21, Nr. 9 (Slutnummer): Redogörelse för Verksamheten vid Statens Skogsförsöksanstalt under år 1924. Pp. 339-357. (Stockholm.)

Department of the Interior, United States Geological Survey. Water-Supply Paper 517: Water Powers of the Great Salt Lake Basin. By Ralf H. Woolley. Pp. xvi+270+18 plates. 30 cents. Water-Supply Paper 521: Surface Water Supply of the United States, 1921. Part 1: North Atlantic Slope Drainage Basins. Pp. vi+294+2 plates. 25 cents. (Washington: Government Printing Office.)

Department of the Interior, United States Geological Survey. Bulletin 750-D: New and Known Minerals from the Utah-Colorado Carnotite Region. By Frank L. Hess. Pp. 63-78+plates 4-11. Bulletin 750-E: Deposits of Magnesia Alum near Fallon, Nevada. By D. F. Hewett. Pp. 79-86. Bulletin 750-F: Molybdenite in the Rocky Bar District, Idaho. By Frank C. Schrader. Pp. 87-99. Bulletin 751-C: Geology and possible Oil and Gas Resources of the Faulted Area south of the Bearpaw Mountains, Montana. By Frank Reeves. Pp. iv+71-114+plates 10-14. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, JANUARY 24.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11 A.M.—Miss E. M. Blackwell: An Outline of the Life History of *Phytophthora Castorum*, Schroet.—H. R. Briton-Jones: The Diseases known as "Bark Canker" and "Die-back" of Fruit Trees.—J. Ramsbottom: Fragmenta Mycologica (II.).—Dr. M. C. Rayner: Sectoring in Cultures of *Phoma radicis Callunæ* Rayn.—E. S. Salmon: The Epidemic Appearance in England in 1924 of a "Downy Mildew" of the Hop.

MONDAY, JANUARY 26.

ROYAL IRISH ACADEMY, at 4.15.

INSTITUTE OF ACTUARIES, at 5.—C. R. V. Coutts: Notes on Life Assurance Investment Policy.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (IV.). Neanderthal Man in Malta. A Review of the Racial Characters of the Inhabitants of Southern Europe in later Pleistocene Times.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—S. W. Melsom and others: Discussion on the National Physical Laboratory and its Work.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at the Great Northern Hotel, Leeds), at 7.15.—The Donnan Equilibrium in Chemical Industry.—Prof. H. M. Dawson: The Donnan Membrane Equilibrium Hypothesis.—W. R. Atkin: The Donnan Equilibrium in the Leather Industry.—J. B. Speakman: The Donnan Equilibrium in the Textile Industry.—Prof. N. M. Comber: The Donnan Equilibrium in Soil Phenomena.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at *Armstrong College*, Newcastle-on-Tyne), at 7.15.—*L.* H. A. Carr: The Use of Induction Regulators in Feeder Circuits.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Institution of Mechanical Engineers), at 7.30.

ROYAL SOCIETY OF MEDICINE, at 8.—G. F. Cale Matthews: A Case of Long-standing Insomnia cured by the Extraction of Pulpless Teeth.—L. E. Claremont: The Problem of Pulpless Teeth.

ROYAL SOCIETY OF ARTS, at 8.—V. E. Pullin: Radiological Research—a History (II.) (Cantor Lectures).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Brig.-Gen. the Hon. C. G. Bruce and Major Northey: Nepal.

MEDICAL SOCIETY OF LONDON, at 8.30.—Prof. A. Castellani: Parenteric Fevers.

TUESDAY, JANUARY 27.

ROYAL DUBLIN SOCIETY (in Royal College of Surgeons, Dublin), at 4.15.—G. Browulee: The Interpretation of certain Empirical Standards in their Application to Irish Butter.—Prof. E. A. Werner: The Decomposition of certain Amino-Acids by Alkaline Hypobromite.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—W. R. Dunlop: Economic Research in Tropical Development, with Special Reference to British Guiana and British Malaya.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. H. R. Hall: The Connexion and Relations of the Prehistoric Greek and Ancient Egyptian Civilisations (I.).

INSTITUTION OF CIVIL ENGINEERS, at 6.—Dr. E. H. Salmon: The Southampton Floating Dock.—F. E. Wentworth Sheilds: Southampton Floating Dock. Subsidiary Works.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 7.—A. E. Berriman: A Review of the Rating Question.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Sir Alexander B. W. Kennedy: Petra.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—L. Jefferies: Gearing.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Leeds University), at 7.30.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—J. W. T. Walsh and others: Discussion on The Effect of Internal Obstructions on the Performance of a Lighting System.

WEDNESDAY, JANUARY 28.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (V.). France and Germany.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Section) (at 244 Deansgate, Manchester), at 6.30.—W. D. Williamson: The Respective Spheres of Petrol, Steam, and Electric Commercial Vehicles.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at the Midland Institute, Birmingham), at 7.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—The Use of the Microscope in the Dairying Industry:—Prof. R. S. Williams: The Microscope of Fundamental Importance to the Industry.—N. Wright: The Structure of the Udder, Normal and Abnormal.—A. T. R. Mattick: The Differentiation of the various Cells found in Milk.—L. J. Meanwell: The Application of the Microscope to the Detection of Tuberculous Infection.—*J. Golding*: Fat Globules.—Miss E. R. Hiscox: The Separation and Identification of Micro-organisms causing Faults in Milk Products.—J. E. Barnard: The Elementary Principles of Microscopical Illumination (2). Self-luminous Objects (Lecture Demonstration).

ROYAL SOCIETY OF ARTS, at 8.—C. A. Baker: The Electrical Equipment of the London County Hall.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Mechanical Engineers), at 8.—B. W. Clarke, S. G. M. Ure, and Prof. J. W. Hinchley: Studies in Filtration.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. M. D. Eder: Substitution.

THURSDAY, JANUARY 29.

ROYAL SOCIETY, at 4.30.—P. M. S. Blackett: The Ejection of Protons from Nitrogen Nuclei, photographed by the Wilson Method.—R. E. Gibbs: The Variation with Temperature of the Intensity of Reflection of X-Rays from Quartz and its Bearing on the Crystal Structure.—R. W. Gurney: (1) Ionisation by Alpha Particles in Monatomic and Diatomic Gases, (2) The Stopping-Power of Gases for Alpha Particles of Different Velocities.—Dr. W. E. Curtis: The Fulcher Hydrogen Bands.—W. L. Webster: The Magnetic Properties of Iron Crystals.—*To be read in title only*.—A. E. Ingham and J. E. Jones: The Calculation of certain Crystal Potential Constants and on the Cubic Crystal of least Potential Energy.—E. C. Stoner and L. H. Martin: The Absorption of X Rays.—F. H. Schofield: The Thermal and Electrical Conductivities of some Pure Metals.—M. de Sélincourt: The Effect of Temperature on the Anomalous Reflection of Silver.—T. L. Ibbs: Thermal Diffusion Measurements.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Properties and Structure of Quartz (I.).

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Prof. C. H. Desch: Recent Developments in the Cement Industry.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 8.—Sir W. Peter Rylands: The Philosophy of Welding.

ROYAL SOCIETY OF MEDICINE, at 8.30.—Discussion: Radiotherapy and Electrotherapy in Diseases of the Bladder and Prostate.

FRIDAY, JANUARY 30.

ROYAL DUBLIN SOCIETY, at 4.30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Recent Discoveries of Fossil Man (VI.). Recent Discoveries of Fossil Man in England and their bearing on the Early Distribution of Racial Types in Europe.

INSTITUTION OF MECHANICAL ENGINEERS.—Discussion: Alternatives to the "Clash" Type of Change-Speed Gear for Motor Vehicles.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—P. C. W. King: The Evolution of the Airship.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—A. J. Broughall: The Utilisation of Waste Steam.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institute, Middlesbrough), at 7.30.—F. D. Verrill: Shipyard Pneumatic Plant and Pneumatic Riveting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. Ambrose: Notes on High Voltage Electrical Transmission (Lecturette, Slides).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. W. Gregory: The Mountain Structure and Geographical Relations of South-Eastern Asia.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Section).

PUBLIC LECTURES.

SATURDAY, JANUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: Rough Stone Monuments and their Builders.

MONDAY, JANUARY 26.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: Constitution of International Labour Organisation.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Leeds University), at 5.15.—Sir Richard Paget, Bart.: The Nature and Synthetic Production of Human Speech.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Some Results of the Excavations of Ur.

ROYAL SANITARY INSTITUTE, at 5.30.—Prof. H. R. Kenwood: Introductory Lecture to Students in the several Courses of the Institute.

TUESDAY, JANUARY 27.

KING'S COLLEGE, at 5.30.—Rev. Prof. W. R. Matthews: Philosophy and Religion.

UNIVERSITY COLLEGE, at 5.30.—Prof. G. Elliot Smith: The Evolution of Man.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Leeds University), at 8.—Prof. A. Gilligan: The Geology of Yorkshire: The Effects of the Glacial Period.

WEDNESDAY, JANUARY 28.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—The Principles of Design as applied to Textiles.

THURSDAY, JANUARY 29.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. H. Hall: The Records of Famine in Mediæval England (as illustrated by the Manorial Rolls of the Bishopric of Winchester).

FRIDAY, JANUARY 30.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Philosophical Hall, Leeds), at 8.—Prof. J. Garstang: The Archæology of Palestine.

SATURDAY, JANUARY 31.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Empire of Egypt.



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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 2884, VOL. 115]

Early Activities of the Royal Society.

DURING the past twelve months NATURE has published, week by week, a column of selected extracts from Dr. Birch's "History of the Royal Society," under the title of "Early Science at the Royal Society." Its commencement was the subject of an explanatory note in the issue of February 9, 1924. The series has run the allotted period, and now some kind of retrospect of the discussions, experiments, and policy of the circle of men who were the promoters of the Royal Society, and of experimental inquiry in general, may be of advantage.

The series comprised the years 1660–87, an interval marking initial, yet fruitful, efforts to establish something that should be permanent in the English commonwealth of knowledge, something that should be shaped out and handed down to others as a reality. The accounts (in brief) of schemes propounded and experiments performed will, it is hoped, have been the means of bringing readers of NATURE into the atmosphere of patient endeavour which animated the founders of the "New Philosophy." We can, all the more readily, picture them forgathering at Gresham College in harmonious conclave and intent. True, as time proceeded, as mind encountered mind, weighty criticisms were offered, whilst dissensions, not quite of a milk-and-water type, arose; notwithstanding such intrusions, through all the same high resolve is maintained, the same sense of original responsibility is apparent. The grip of national conflict was over, perhaps forgotten, and things bespeaking mental awakening held indisputable sway. Harrington's contemptuous comment that they were, in early constitution, an assembly of men who had an excellent faculty of magnifying a louse and diminishing a commonwealth became empty and barren.

Inquiries in the departments of natural history, physiology (as understood), chemistry, medicine, mechanics, and astronomy were actively fostered, the last named especially. The vegetation of plants was frequently the subject of discourse. Evelyn's "Sylva" appeared in 1662. In 1673, Grew's microscopical observations of the texture of a piece of a walnut-tree section were discussed. The history of the silk-worm, in Latin, by Signor Malpighi, was sent in 1668, and ordered to be printed. The operator was directed to try again the feeding of spiders upon one another. In 1669, Robert Hooke (versatile and elusive, yet a veritable Master of the Ceremonies) produced a contrivance to see whether a mechanical muscle could be made by art, performing without labour the same office which a natural muscle did. Robert Boyle presented his "Sceptical Chymist" in 1679, which a committee were to peruse to see what could be learnt

from it. Moray presented the stones taken out of the Lord Balcarres' heart, in a silver box, together with a written account of the dissection of his body, attested by a physician. Only, in case the deceased lord's mother should claim it, it was not to be denied her.

Much time was taken up in discussing transfusion questions and arranging experiments. But what are we to think of Dr. Clarke's proposition that a man hanged might be begged of the King, to try to revive him, and that, in case he were revived, he might have his life granted him? In 1681 (Wren in the chair) it is recorded that Mr. Flamstead having cavilled against the method shown by Mr Hooke of describing a parabola, the Society desired it again. Upon which the president declared it was true and certain. Honour to whom honour is due. Sir Robert Moray had presented from Prince Rupert an instrument of his Highness's invention for "casting any platform into perspective." It was ordered that the president (and others) wait upon the prince, return him the humble thanks of the Society, and show him an instrument of Dr. Wren's invention for casting any natural object into perspective. In 1666, Mr. Peter Lely was moved to communicate curiosities in the art of painting. Evelyn, Hooke (and others) were to meet and consider particulars. Report was made of willingness to serve the Society. We have, however, been unable to glean any issue.

His Majesty King Charles II. came upon the scene with a fanfare, thanks to the interest of Sir Robert Moray, the courtier, and the gentle scholarly Evelyn. It was long hoped and expected that his Majesty, as founder, would attend one of the meetings. However, he never came. "Early Science" speaks of the appointment of a committee to consider the manner of the King's reception and the conduct of chosen experiments, one being the contriving of optical pictures.

There must, however, have been considerable personal intercourse with his Majesty. Christopher Wren was charged by express command to make a great globe of the moon. On January 23, 1667/8, the operator was ordered to hasten the making of a thermometer for the use of the Queen. In the following year the president took notice that an experiment shown to the Society by Robert Boyle did not succeed at first at Whitehall, but at last it succeeded very well, and in his Majesty's presence. "Early Science" has omitted a pathetic story. In 1663, in a discussion of a new way of hatching pigeons, Sir Robert Moray was able to relate that the King, *when very young*, meeting with a blackbird's nest, and finding but one young one in it, carried it home in the nest, and put it to a thrush in a cage, who fed the blackbird as carefully as if it had been her own, but with this difference, that whereas other birds fed their young ones just before they feed themselves, the thrush fed herself before the blackbird.

The Society enjoyed the supreme advantage at its foundation, and for fourteen years, of the secretaryship of Henry Oldenburg. This accomplished man, a Latin scholar and able linguist, laboured indefatigably and exclusively in its interests with a true spirit of service. With extraordinary zeal he maintained a voluminous correspondence with philosophers abroad, and hence linked up and broadened the philosophical learning of his time. He would seem to have done his best to avoid the credulous and trivial.

Foreign visitors came ever and anon, providing a useful interchange of views. The Danish Ambassador was brought by Evelyn on February 13, 1660/1, and was given a sight of Mr. Boyle's air-pump. The Genoese Ambassador came on January 29, 1661/2. Leibnitz was present at the meeting of January 22, 1672/3 (Hooke, Boyle, and Oldenburg were there). The following year he was elected into the Society. Huygens was elected on June 22, 1663, at the same time as Sorbière (who afterwards narrowly escaped being struck off the roll). The Moroccan Ambassador was a visitor in 1682 and inscribed his name in the charter-book in Arabic. Later, he was responsible for an account of a person who was always dumb, except at noon! The Florentine envoy came in 1685 and was entertained by Papin.

The president and officers were at one period gravely concerned over the arrears of subscriptions, a very large total liability having arisen by degrees. Various fellows undertook to approach the forgetful ones. Not much advance was made in the case of Edmund Waller, the poet, though certainly his interest in the organisation was no more than dilettante. It was mentioned that he had put it off with an expression of merriment; that he thought it best to forget and forgive one another for what was past, and to begin on a new score. This was very disturbing to Oldenburg. In point of fact, Waller never did pay.

Pepys was elected February 15, 1664/5, and admitted the same day. On January 14, 1674/5, at a meeting at which Mr. Pepys and the Earl of Aylesbury were present, each took a day when they would provide a lecture for the Society. The latter excused himself, subsequently paying a fine of forty shillings. Although not recorded, it would appear that Pepys failed to keep his promise. We have found no reference to this lapse in the well-known Diary.

Limitations of space forbid further review; and so we take leave of these "early philosophers," grateful for efforts which shaped into actualities, and for their rich legacy of an essentially English foundation.

T. E. JAMES.

The Physiology of Colour-Change.

The Pigmentary Effector System: a Review of the Physiology of Colour Response. By Dr. Lancelot T. Hogben. (Biological Monographs and Manuals.) Pp. xi+152. (Edinburgh and London: Oliver and Boyd, 1924.) 10*s.* 6*d.* net.

AMONG the many unsolved problems of animal life, the significance of pigmentary colour and of rapid colour-change is one of the most elusive and attractive. Unlike the case of chlorophyll, the pigments of animals have no direct physiological value so far as really critical evidence goes at present. The colouring matters of birds' eggs, for example, the variable colouring of the egg of the guillemot, herring-gull, or cuckoo, has not yet been shown to possess the slightest relation to the welfare of the chick; nor has the (genuine) coloration or lack of colour in the skin or deeper tissues been proved conclusively to play a definite part in the welfare of the animal body. On the other hand, adaptational and survival value has been freely admitted, until recently, to account for the complex and exquisitely balanced correlation between coloration, habit, and environment in a large number of instances, of which insects and fishes offer the most notable examples. The difficulty that has made biologists sceptical of arguments that are used to prove protective, warning, and epigamic significance in animal colouring, lies in the absence of objective standards of excellence. How much does it benefit a flat-fish to fit so exactly into its niche and to stay there? How much does the note of warning avail? What was the value of the rough study in pigment before the painted animal canvas became amenable to the criticism of life? Are pigments or structural colours anything more than indices of chemical and physical structure, and is their biological value real or apparent only?

To these questions Dr. Hogben's book offers no direct answer, and much more analytical work has to be done before we can put really intelligent questions about animal coloration to the test of experiment and observation. What this excellent book does, is to analyse critically all that is accurately known about those quick changes of colour for which the chameleon has gained a wholly undeserved notoriety and in which it is excelled both in rapidity and range of repertoire by many fish, frogs, prawns, and cuttle-fish. Dr. Hogben's book is a critical review of the factors governing colour-change in vertebrates and Crustacea, and his special qualifications for this work lie not only in his own original contributions to experimental chromatology, but also in the judicial way in which he deals with the evidence and shows in each case what the problems are that now await solution. Such a survey will only require to be known to be at once appreciated by zoologists and physiologists as an indication of the new *rapprochement* that is taking place between these two bodies of workers, and that constitutes a reversion to that earlier practice when, as the editors of this series remark in their preface, "animal physiology was not yet divorced from morphology."

Colour-change is a response by the pigment cells of the skin to change in the external or internal environment. It takes the form of radiation of pigment, or of pigmented protoplasm, from the body of the cell into its spreading branches, an injection as it were of granules into a pre-existing dendritic pathway. When this occurs the general effect is darkening of tone. The frog, for example previously yellow, now becomes dark green or almost black Again, the change may be one of pallor occasioned by the inflow of pigment from the branches into the central cell-body leaving, therefore, relatively large tracts of skin uncoloured or exposed so that the less mobile but lighter coloured groundwork—the body of the colour-scheme—becomes thereby visible. Such changes of coloration may be general or local. They may be slow or almost instantaneous. They may occasion a passing flush or a momentary pallor, or they may persist so long as the animal that exhibits them remains in a chosen habitat. They may come on at night and again at daybreak, and the rhythm of nocturnal and diurnal colour contrast may persist even when day is turned into night or night into day. As Lord Lister said in his classical paper on "The Pigmentary System of the Frog" (1858), the pigment cells "form a tissue with entirely new functions which, though apparently allied to the most recondite phenomena, yet produce very obvious effects."

Dr. Hogben's book is a commentary on these prophetic words. The pigmentary tissue gives evidence, accumulated now from the side of endocrinology as well as from those of neurology, of ecology, and of toxicology, of being "allied to the most recondite phenomena." Lister advocated the colour-changes and pigment-cells in the frog for use as "indicators" of the effects of poisonous substances on the animal organism. It has taken exactly sixty years for his suggestion to be carried into effect. The chromatophores of the frog and of the fish are now the most delicate tests of reaction to physiological and pharmacological stimulation; and as there exists a close if not an exact correlation between the action of drugs on a given tissue and those of the sympathetic and parasympathetic (or in the modern sense the "autonomic") nervous systems, change of colour—the radiation and

retraction of pigment in the cell—acquires merit not only in itself as a biological factor, but also as a signpost in the maze of hormonic and autonomic changes that take place in the body.

As an example of this modern development of chromatology we may take the case of an American fish Fundulus Spaeth has shown that the tissue overlying a few detached scales and containing the mobile chromatophores can be studied in a living state under the microscope and the reactions of these pigment cells to various agencies can be recorded. Normal saline promotes expansion of the pigment into a dendritic form, whilst potassium and alkaline salts generally cause immediate retraction. These opposing effects can be balanced by using three reagents in suitable combination (NaCl 6 vol. + KCl 1 vol. + $CaCl_2$ 0·35 vol., N/10 in each case). Equilibrium having thus been attained, it is now possible to determine the effect of any given pharmacological reagent quantitatively by measuring the time taken by, and the extent of, pigmentary response. In this way, Spaeth has accomplished a pharmacological assay, and in the course of it he has discovered the remarkable effect of barium chloride (N/10). When this is applied to the pigmented tissue, the granules at once flow centrally and remain retracted for half an hour. Then the chromatophores at the edge of the scales suddenly radiate their pigment but almost immediately retract it again. There then follows a "Piccadilly effect." The pulsations begun by the cells at the edge of the scale, spread centripetally from cell to cell, increasing in amplitude of vibration as time goes on. Eventually the whole group of pigment-cells associated with each scale pulsates for several hours between the extremes of contraction and expansion.

The importance of these observations and of others on the effect of ergotoxine and adrenalin lies in the fact that the pigment-cell of the fish has one sympathetic nerve-ending and probably one only. Moreover, the pigment-cell, if not a modified smooth muscle-fibre, is a member of a closely allied "effector system," and the evidence it supplies as to the action of drugs and of hormones (such as ergotoxine and adrenalin respectively) throws light upon the action of these substances in the roots of the mammalian uterus. It is indeed an unexpected development of biological research to find the study of pigment a help to the gynæcologist.

The general conclusions that Dr. Hogben draws from his study of the factors governing colour-response in the lower vertebrates and Crustacea are based on a critical examination of the evidence. In the Amphibia, he concludes that the pituitary (posterior lobe) is the source of the effective stimulating substance that, in correlation with the action of natural stimuli, regulates colour-response; and that nervous control of the chromatophores, even if it exists, plays a very subordinate part. In fishes the weight of regulation lies, on the contrary, with the nervous system and owes little to hormonic influence. In reptiles, pallor is the result of adrenalin affecting the chromatophores, but the flushing of the skin with colour is not clearly understood. Finally, the factors for colour-change in Crustacea are ably dissociated and set out on the basis of Gamble and Keeble's work on Hippolyte, and the work ends with a short appendix on the chromatophores of cephalopods.

The volume, from its style, critical treatment, and breadth of view, should enhance the author's reputation and give encouragement to the editors and publishers to pursue the excellent object they have in view—the production of monographs on experimental biology by those who have something to say and are able to say it.

F. W. Gamble.

The Recognition of Minerals by their Optical Characters.

(1) (*a*) *Les méthodes de Fédorof et leurs applications à la détermination des plagioclases.* Bull. Suisse de Minéralogie et Pétrographie, tome iii. fasc. 1-2, par L. Duparc et M Reinhard, 1923. (*b*) *La détermination des plagioclases dans les coupes minces*, Mémoires de la Société de Physique et d'Histoire naturelle de Genève, vol. 40, fasc. 1, par L. Duparc et M. Reinhard, 1924.

(2) *Mikroskopische Physiographie der petrographisch-wichtigen Mineralien.* Begründet von H. Rosenbusch. Band 1. Erste Hälfte: Untersuchungsmethoden. Fünfte, völlig umgestaltete Auflage, von Prof. Dr. E. A. Wülfing. Zweite Lieferung. Pp. iv + 253-532. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung G.m.b.H., 1924.) n.p.

THE employment of crystal optics in the determination of minerals is a very special branch of applied physics which has been industriously pursued in recent years, but it is the task of distinguishing between the different plagioclases that has called for the greatest refinements. These important constituents of igneous rocks present the closest resemblance to one another, but vary greatly in composition, forming a continuous series from albite, soda plagioclase rich in silica, $Na_2OAl_2O6SiO_2$, to anorthite, lime plagioclase, $CaOAl_2O_3.2SiO_2$, which contains much less. They differ, however, in the orientation of their axes and planes of optical symmetry relatively to their crystal structures, and in other optical characters. The foundations of these investigations were laid by Schuster,

in Germany, and Michel Lévy in France, but it is to the great Russian crystallographer Fedorov and his pupil Nikitin that we owe the latest and most far reaching developments, and they have now been rendered generally available by Duparc and Reinhard in Switzerland, and by Wülfing in Germany, in the works before us

For this purpose a microscope with a theodolite stage is employed, that is to say, one in which a thin rock slice, containing a section of plagioclase, can be rotated successively on at least three different axes at right angles to one another, so that, with the help of glass hemispheres to prevent refraction, it may be examined from any direction As the amounts of these rotations are recorded on graduated circles or arcs the resulting position is exactly determined

It is well known that plagioclase almost invariably occurs in twin crystals consisting of at least two differently orientated component parts which are related by the fact that a rotation of one of them through an angle of 180° about a definite direction, the twin axis will bring it into parallelism with the other There are a number of different kinds of twins of plagioclase, each with its characteristic twin axis but it is by no means always easy to say which is present

By a series of manipulations of the theodolite stage the three axes of optical symmetry, the so-called 'axes of elasticity,' with the refractive indices α β, γ, of one of the components of the twin crystal are brought in turn into a position parallel to the external horizontal axis of rotation of the theodolite stage, and their positions relatively to the normal to the thin rock section are read off on the graduated circles or arcs These axes of optical symmetry are represented by three points on a stereographic projection in which the normal to the rock slice is the centre of projection

The same procedure is followed with regard to the other component of the twin, and the three corresponding points are inserted in like manner on the same projection. If now great circles are drawn through each of the pairs of points representing corresponding axes of optical symmetry, the three great circles will meet in two opposite points, only one of which will as a rule be represented on the projection. Such a point (or points) will represent the twin axis, and its angular distance from the axes of optical symmetry is then measured, but so that if it exceeds a right angle the supplement is taken.

Recourse is now had to another stereographic projection. This is on tracing paper, and in it the point representing the intermediate axis of optical symmetry with refractive index β occupies the centre, and the other two with refractive indices γ and α are on the circumference at a distance of 90° from one another The position of the twin axis can now be indicated, because its angular distances from the three axes of optical symmetry are known They are of course the same for both components of the twin The new projection is next compared with a standard projection on the same principle which will be found in the works referred to above It shows the positions relatively to the axes of optical symmetry of the crystal directions of the plagioclase especially the twin axes Instead of the crystal directions being considered as fixed and the optical directions as varying with the composition of the plagioclase exactly the opposite convention is adopted, the axes of optical symmetry being regarded as fixed and the crystal directions as varying with the composition The position of the point representing the twin axis of a twin according to any particular twinning law will therefore vary with the composition of the plagioclase, and the points representing such a twin axis in all the different plagioclases will form a curved line, one end of which will correspond to albite and the other to anorthite The intermediate points corresponding to plagioclases with 10 20 30, etc of anorthite are figured accordingly The standard projection shows a number of such lines, each corresponding to a particular kind of twinning

By placing the tracing paper with the projection of the twin axis under investigation over the standard projection so that the corresponding axes of optical symmetry coincide and noticing (1) on what line in the standard projection the twin axis in question falls, and (2) on what part of that line, it is known at once (1) what is the nature of the twinning, and (2) what is the proportion of anorthite present in the plagioclase

The optical axial angle is also obtained in the course of the investigation

In the publications by Duparc and Reinhard this method is explained with a wealth of diagrams and examples, and the older methods are also fully described and illustrated in greater detail than by previous authors A full and clearly illustrated account of the Fedorov method is also given in the Stuttgart publication This forms, however, only a small section of the new edition by Wülfing of the great classical work by Rosenbusch on microscopical petrography It contains in addition a thorough exposition of the general theory of the microscope, of which petrologists, as a whole, know far too little Considerable space is devoted to the description of different types of petrological microscopes and their accessories and their use. The high standard of previous editions is maintained and even surpassed, for all the latest advances will be found in its pages JOHN W EVANS

The British Portland Cement Industry.

A Hundred Years of Portland Cement, 1824–1924. By A. C. Davis. Pp. xxii + 282. (London: Concrete Publications, Ltd., 1924.) Cloth, 21*s*.; leather, 25*s*.

SOME books are of transient value and others increase in value as time progresses. This work undoubtedly belongs to the latter class. The author's intimate knowledge of the cement industry, its complex business ramifications, and changing methods of manufacture, has enabled him to produce a book which must be regarded as authoritative over the period of which it treats, so far as the British industry is concerned. No attempt is made to follow the development of the industry in other lands, beyond what is essential for understanding it in our own.

After a brief survey of the knowledge of the ancients regarding limes and cements, and a critical examination of John Smeaton's work in 1756, the tangle of men and names associated with the beginning of the industry in different parts of England is gone into in considerable detail, this section of the work being illustrated by excellent actual photographs of historical value. The cement industry is now so rapidly changing that all these old landmarks of progress may in the near future be swept away, and the men who took an active part in its development and remember the conditions which prevailed in the industry even a few decades ago are now fast disappearing. The work, therefore, is valuable in that it gives an accurate account of the industrial conditions and influences which prevailed in the industry, following the gradual change until we reach modern conditions, when great accumulations of capital, expensive machinery, and accurate scientific control by routine chemists and scientific engineers are essential for successful manufacture.

What must strike the reader of this book is the unattractive personality and lack of education of the pioneers of the industry. The work of Joseph Aspin, and especially of his son William, is gone into in some detail. Did any of the Aspins really know how to produce the substance known now as portland cement, a substance which is produced by increasing the heat in the kilns sufficiently to cause the intimate union of the components accompanied by semi-fusion or "sintering"? The author decides that they did not. The original patent of Joseph Aspin is obviously deficient, and it has been suggested that the inventor suppressed vital information in order to mislead competitors. Mr. Davis decides that the Aspins never made what was now known as portland cement, although Joseph Aspin introduced what has proved the extremely successful trade name of "Portland Cement," and in this showed considerable ability. The fact of the matter is that both the Aspins were ignorant but gifted men, deficient in education and devoid of all scientific knowledge.

Joseph Aspin, the father, was a bricklayer by trade, a Yorkshireman, who seems to have distrusted his fellow-manufacturers to a considerable extent, as he surrounded his factory with walls 20 ft. high and carried on the manufacture as a sort of mystery. His son William continued this tradition, mystifying his workmen by sprinkling various secret chemicals from a tray on to the contents of the kilns in front of his workmen, with the result that he not only repeatedly succeeded in raising capital after each failure, but also succeeded in baffling inquiries right to the end. After repeated failures he died in Germany as the result of a fall while in an intoxicated condition, his last partner having got rid of him by a cash payment of 2500 marks.

This origin is no doubt the cause of the suspicious attitude towards all people who claim superior knowledge, which even to-day prevails to some extent in the industry, chemists and scientific workers generally being regarded with marked disfavour.

A man of greater ability than either of the Aspins was I. C. Johnson, who spent some time in spying around Aspin's works with the view of discovering his "secrets." He apparently quite met his match in the Yorkshireman, because the sample of material that Aspin supplied him with turned out to consist largely of calcium phosphate, which led Johnson to collect all the bones in his neighbourhood and burn them so as to create a mighty stench. Needless to say, he did not make portland cement with this material, but promptly silenced any criticism by blaming the analyst for making an incorrect analysis.

Johnson himself seems to have possessed only elementary scientific knowledge, but his ability was undoubted, and by means of numerous experiments made on the "trial and error" principle, he undoubtedly succeeded in making portland cement as we know it to-day. He also introduced the chamber kiln into England, and the enormous British industry which developed was largely due to this invention.

The cement industry seems to have been carried on in the crudest way, without scientific control of any sort, and a graphic description of the way a cement works was run in 1886, on p. 211, brings this aspect home to the reader, especially when a chemist will remember that at this time the German chemical firms for years past had been not only employing routine chemists to control output, but also, so far back as 1883, the Badische Anilin und Soda Fabrik was actually employing a director of scientific research at a salary of 5000*l*. per annum.

It was the shock of foreign competition which led to

improved methods of manufacture. Routine chemists were engaged to control output and material, the rotary kiln was reintroduced from the United States (after its initial invention and failure in Great Britain), and, generally, the industry took on its modern form The author claims, and the reviewer thinks correctly, that at the present time the British cement industry is conducted with practical skill and accurate scientific control which equals, if it does not exceed, that exercised by any other country, but that great improvements are still possible in manufacture.

The author furnishes an interesting chapter on the progress of scientific research in the industry. To sum up, the work is a valuable one, and gives an exact and very accurate picture of the cement industry as it exists to-day, and illustrates clearly the successive changes introduced into the industry in the successive decades The work will enhance the author's reputation as one of our leading authorities on cement.

GEOFFREY MARTIN.

Prehistoric Man.

Fossil Man in Spain. By Prof. Hugo Obermaier. (Published for the Hispanic Society of America.) Pp. xxviii+495+23 plates (New Haven: Yale University Press; London. Oxford University Press, 1924.) 23s. net.

DR. HUGO OBERMAIER was born in Bavaria, worked under Hoernes at Vienna; studied glacial geology throughout the Alps with Penck; excavated for the Prince of Monaco the largest and most important prehistoric dig at present known at Castillo (Cantabria); was professor, until the War broke out, at the Institute of Human Palæontology founded by the same Prince at Paris; and now is professor of prehistoric archæology at the University of Madrid. With such a record we may well expect a fine work and Dr. Obermaier has not disappointed us. To the German thoroughness and power of taking pains in details born in him, there has been added, from long association with the French, the Latin clarity of thought and power of intuition. Madrid has done well to envisage all this and come forward with a professorial chair when war difficulties approached. It is not too much to say that Dr. Obermaier is one of the two most learned prehistorians now alive.

It was in 1912 that his book "Der Mensch der Vorzeit" appeared, and this was followed in 1916 by "El Hombre Fosil," with a translation of which from the Spanish into English, accomplished thanks to the enterprise of the Hispanic Society of America, we are now concerned. It is a monumental work that will long retain a foremost place in the prehistorian's library, though no specialist has heretofore been able to do without the original Spanish edition. A few changes have been introduced in the new version and the book has to a large extent been brought up-to-date. This has been facilitated by the fact that, owing to innumerable delays in the United States, the production of the English edition is coinciding in time with the preparation of a second revised edition in Spanish, and it has been found possible to incorporate some of the new matter in the present volume. There are also alterations and additions in the plates, which are many and excellent. In the reviewer's opinion the English title is somewhat misleading, as the work is really of a general character, though stress is laid in the illustrations and text on the Iberian peninsula—"Fossil Man, with special reference to Spain" would really be a more accurate description.

The book opens with an account of Tertiary times and the problems of Tertiary man, followed by an exceedingly able summary of the existing knowledge of the Glacial epoch with lists of the plants and animals found.[1] Next comes a description of the various Palæolithic industries, a special chapter being devoted to the Iberian peninsula during these times It is pleasant to see here the introduction of a new plate figuring a general view of the cave of Castillo, where the reviewer had the privilege of assisting at the digging of this really wonderful site under Dr Obermaier's direction. Palæolithic art and the problems of chronology are then discussed, and the volume concludes with two chapters on fossil man and the transition from Palæolithic to Neolithic times successively. Not the least valuable part of the work is the group of appendices, notes and bibliography, which, in the English edition, are separated from their respective chapters and placed together at the end. Some minor changes in arrangement have been introduced which seem to be on the whole an improvement. Thus the order of the table on page 64, giving the archæological sequence of the various industries in the Somme valley, has been reversed from that of the Spanish edition, the latest deposits being placed at the top instead of at the bottom of the list. There are also one or two minor misprints of little importance, for example in the initials of at least one author quoted.

Of course, in any work of this nature there must be, besides basal and incontrovertible facts, theories which are not necessarily accepted by every one. For example, Dr. Obermaier's suggestion as to the significance of the Azilian painted pebbles, that the markings really represent conventionalised human figures, has always seemed to the reviewer difficult of credence; and his

[1] A translation of the whole of this chapter from the Spanish edition is given in the appendix—the main text contains a rewritten version not quite so overloaded with technicalities and mere lists.

comparison of them with the undoubted conventionalised figures of the Spanish Third Group paintings seems open to the objection that there is by no means an exact similarity, and, moreover, that the latter are very possibly of a much later date. However, these are points that further finds will no doubt elucidate.

It only remains once more to congratulate Dr. Obermaier on his book, and the Hispanic Society of America on having been the instrument of introducing it more fully to English readers. M. C. B.

Fluid Velocity and Pressure.

The Measurement of Fluid Velocity and Pressure. By J. R. Pannell Edited by R. A. Frazer. Pp. vii+135. (London: E. Arnold and Co, 1924.) 10*s* 6*d*. net.

TO a large extent this book is a product of the advent of aeronautics, and its preparation would not have been possible fifteen years ago. The author passed through the period during which no accurate means existed of measuring the velocity of fluids, and was intimately associated with the history of the needs of such methods as he describes. At the present moment, the calibration of anemometers depends on a solitary series of absolute measurements at the National Physical Laboratory, part of which was conducted by the author himself. The work of Stanton on wind pressure in 1903 was the first contribution to the production of the tube anemometer illustrated on p. 13; its establishment as a satisfactory standard followed the formation of an Aeronautics Department, and the development then reached the stage at which a skilled workman can reproduce the instrument so accurately as to give speed within one per cent. without special test.

Many other anemometers, including those established in aeronautical practice, are described together with manometers and balances for the measurement of fluid pressures. In the description of one of the manometers —p. 92—the short statement occurs that "the horizontal tubes are filled with a solution of distilled water and common salt of density 1·07 . . ." and no reference is made to the lengthy inquiry made by the author before this solution was decided on. In the early days of the use of tilting manometers of the Chattock type, distilled water was tried, with the result that renewal was necessary after each fortnight or three weeks. The glass work had then to be thoroughly cleaned. As a result of Pannell's efforts the period between cleansings was raised to a year or more and the operation of cleaning greatly facilitated. In this and in much of the material in the book under review there is just that precision of detail which is helpful to newcomers and will enable them to get to work quickly and safely.

Pannell lost his life when the airship R38 failed, whilst applying his knowledge of instruments to research, and together with his colleagues the author has left a record of which one is proud and of which this book is one item. The volume can be confidently recommended as an excellent statement of available methods of measurements in the motions of fluids, whether the application be in aeronautics, hydraulics, ventilation, or any other of the branches of engineering.

L. BAIRSTOW.

Our Bookshelf.

Soil Management. By Prof. Firman E. Bear (Wiley Agricultural Series.) Pp vi+268. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 10*s*. net.

THE work under notice is a text-book dealing with the application of scientific facts and principles to the practical management of the soil, and is written for the use of students in agricultural colleges who have already taken courses in chemistry, botany, geology, and physics. The requirements of crops and the properties of soils are discussed in the first ten chapters, which are followed by four chapters on the utilisation of the resources of the soil by cultivation operations, crop rotations, etc. The remainder of the book is concerned chiefly with the economic use of fertilisers and of lime. The nitrogen problem is treated with the thoroughness that would be expected from Prof. Bear, who has devoted much time to this question. It is a very common practice in the United States to purchase only phosphatic fertilisers and to depend on the air for nitrogen; on soils which have been cultivated for many years, such a system necessitates the well-managed introduction into the rotation of frequent leguminous crops for green-manuring, and the author is rightly insistent that every effort should be made to utilise such natural nitrogen-fixing agencies to the fullest possible extent for the maintenance of soil fertility.

The illustrative data are taken mainly from American sources, but the application is by no means confined to American conditions. It may, however, be questioned whether the book is not on the whole too advanced for students who "have little or no need for the course except as it may be useful to them in practice or in understanding practice." Certainly the average British student of this type will find it rather stiff reading; but his American cousin is perhaps different. C. T. G.

The Bombyliidæ of the Ethiopian Region: Based on Material in the British Museum (Natural History). By Mario Bezzi. Pp. viii+390: 46 text-figs. (London: British Museum (Natural History), 1924.) 32*s*. 6*d*.

THE Bombyliidæ are a large and highly interesting family of Diptera, and the present monograph forms an important contribution to our knowledge of these insects. In placing the preparation of the volume in the hands of Prof. Bezzi, a wise choice has been exercised.

since that author is well known as one of the leading dipterists of to-day. The book is based upon material submitted to him by the British Museum and the Imperial Bureau of Entomology as well as from the Museums in Cape Town, Buda-Pest, and Genoa, and also from Messrs. Alluaud and Jeannel in Paris. This wealth of specimens, together with those in the author's own collection, has made it possible to produce a monograph of great value. In addition to diagnostic keys and descriptions, all available biological data, however scanty, is included under each species together with notes on the known life-histories. It is hoped that, with the aid to identification thus provided, African entomologists will be stimulated to study the remarkable metamorphoses of these insects Their larvæ are all parasites and have a wide range of hosts. The unexpected discovery of *Thridanthraxabruptus* parasitising the puparia of tsetse-flies is but a bare indication of what awaits investigation in the Ethiopian region. The book is admirably printed and illustrated, while the revision of the English manuscript by Major Austen has ensured this arduous task being carried out capably.

Distillation du bois. Par Prof. G. Dupont. (Encyclopédie Léauté, 2e série.) Pp. xv+284. (Paris: Gauthier-Villars et Cie; Masson et Cie, 1924.) 25 francs.

THE general treatment in this work is on somewhat similar lines to that followed in recent British and American text-books on the subject. Special attention is given to the distillation of resinous woods, and an interesting account of wood distillation plants is included, the text being made clear with numerous diagrams. There is a certain lack of proportion in the presentation of facts. Nearly one-third of the book is given over to an account, such as is available in numerous organic text-books, of the elementary chemistry of acetic acid and methyl alcohol, and of simple derivatives of these, yet the study of the gaseous products from the thermal decomposition of wood is intentionally neglected. Again, the analytical section is considerably restricted. The space occupied by this important subject is only half that given to the preparation and properties of formaldehyde, and it is doubtful if the meagre information therein contained will be of much real value to the analyst.

The monograph cannot be regarded as a handbook for the specialist. It is rather a general account of certain aspects of wood distillation presented in a form which will be attractive to the general reader and science student. J. REILLY.

Aristotelian Society. Supplementary Vol. 4. *Concepts of Continuity: the Papers and Symposia for discussion at the XIVth Joint Session of the Aristotelian Society and the Mind Association, at University College, Reading, July 11-14, 1924.* Pp. vi+240. (London: Williams and Norgate, 1924.) 15s. net.

THE papers read at the summer meeting of the Aristotelian Society and the Mind Association, though inspired with a distinctively philosophical motive, are of more than usual scientific interest All in some form deal with the subject which gives the title to the volume, the concept of continuity.

Prof. Chevalier's article "Le Continu et le Discontinu" is designed to prove that though the problem of continuity is fundamental in mathematics and physics, it can be resolved only by philosophical arguments.

Three of the five symposia deal with scientific problems. One on the quantum theory discusses how far it modifies or can be made to accord with the definitions of continuity accepted in mathematics, physics, and psychology. The papers are by Dr Nicholson, Mrs. Wrinch-Nicholson, Prof. Lindemann, and Prof Wildon Carr. A second deals with the biological problem of the transmission of mental characters This is discussed by Profs. Johnstone, Dendy, MacBride, and Lloyd Morgan. A third deals with the implications of the term "law" in psychology. The papers are by Mr. Wolters, Dr. M'Intyre, and Dr. Levine.

Chemical Thermodynamics: an Introduction to General Thermodynamics and its Applications to Chemistry. By Prof. J. R. Partington. Pp. vii+275 (London. Constable and Co., Ltd., 1924.) 10s. 6d. net.

A NEW edition of Prof. Partington's "Text-book of Thermodynamics with special reference to Chemistry" (1913) has been desired for some time, and those who are familiar with that work will welcome it in its new form under the title "Chemical Thermodynamics" The treatment has been simplified as well as brought up-to-date Any one who is familiar with the large number of relevant papers published during the past decade will marvel at the skill with which the material has been incorporated. The author has made a special feature of the inclusion of much recent work published in American journals. "The accurate experiments, and the ingenious and original treatment, of the American workers on this subject will make all admit gratefully the debt which students in other countries owe to them." A point which teachers will appreciate is that the equations have been stated, so far as possible, in a form capable of direct numerical application, and many examples, with answers, have been provided. It is a convenience to have the numbers of the paragraphs printed on the inside edges at the tops of the pages. The book will prove indispensable to students of chemistry and physics alike.

Spectroscopy. By Prof. E. C. C. Baly. (Text-books of Physical Chemistry.) In 2 vols. Third edition. Vol. 1. Pp. xi+298. (London: Longmans, Green and Co., 1924.) 14s. net.

THE new edition of Prof. Baly's "Spectroscopy" is modelled closely on the original plan. It has, however, been reset in a new *format* with a larger page, so that the number of pages in the first volume of the new edition is about 10 per cent. less than in the corresponding half of the preceding edition. Since the earlier portions of the book are concerned mainly with prism and grating spectroscopes, they have not needed any drastic emendation as a result of the recent developments in the theory of spectroscopy; but attention may be directed to a useful table of standard wave-lengths, covering three pages of the new edition, and to the account that is given of recent work by McLennan and by Millikan on the extreme ultra-violet region of the spectrum.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Limbs and Pigment-Cells.

I NOTICE in a review of Franz's "Geschichte der Organismen" which appeared in NATURE of December 20 a reference to the interesting evolutionary problem of the origin of the limbs of vertebrates. I have no intention of essaying the futile task of endeavouring to influence those whose minds are already made up regarding this problem, but I should like to direct the attention of others to the point that new facts having important bearings upon the problem have come to light in the investigation of the development of these relatively archaic types of vertebrate, Lepidosiren, Protopterus, and Polypterus. A short summary of these facts, and of the conclusions they suggest, will be found in my volume on vertebrate embryology, and the perusal of this summary will, I think, suffice to indicate the grounds for my belief that the older hypotheses referred to by the reviewer will, as knowledge of the relevant facts becomes diffused, be replaced as working hypotheses by the newer view that the limb of the vertebrate has evolved out of a projection from the body-wall which was primitively respiratory in function.

I take this opportunity of directing attention to another statement in recent literature which is liable to cause misunderstanding. It occurs in a book by Dr. L. T. Hogben entitled "The Pigmentary Effector System," where he refers (p. 93) to "Kolliker's work on the South American mud-fish, Lepidosiren." The creature upon which Kolliker worked was of course not the creature known to us to-day as Lepidosiren, not the South American "mud-fish," but the African Protopterus which for a brief period after its discovery was called Lepidosiren. As Dr. Hogben does not refer in his summary of our knowledge regarding the pigment-cells of fishes either to what I have published on the subject, or to what I made known to him by word of mouth, I will state very shortly the attitude that my work upon Lepidosiren caused me to take up, and which I have consistently adopted in teaching for many years. I adhere to the view that the colour change, so beautifully exemplified by the young Lepidosiren—of a deep rich black during the day and practically colourless during the hours of darkness (see *Phil. Trans. Roy. Soc.* B, *192*, *1900*, and *Quart. Journ. Micr. Sci.* 46, 1902), is due to actual change in the form of the black pigment-cells which, under the influence of light, push out their finely branched pigment-laden pseudopodia in a direction parallel to the surface of the body so as to provide a light-proof coat, and, when night falls, draw in their pseudopodia and shrink up to spheres so relatively small as to be without effect upon the general colouring. The considerations which induced this opinion were (1) the appearances presented under the microscope, (2) the fact that the pigment-cells changed their position in the body and therefore necessarily had the power of moving their pseudopodia, and (3) the fact that it was possible by teasing up the night skin to isolate individual chromatophores without their going to pieces as they would be liable to do were peripheral extensions of their body torn through in the operation.

As regards the active functioning of the pigment-cells, there is, I think, a tendency towards over-emphasis of one or other of the factors involved. There is, first of all, the fact that the healthy activity of the chromatophores, as of all other cells in the body, is dependent upon the internal medium of the body being of approximately "normal" composition, and recent work by various investigators, including Hogben, has served to emphasise the special importance of particular components of the internal medium provided by the adrenal or the pituitary organ, slight fluctuations in the proportion of this particular component evoking specific functional responses. There is, secondly, the nervous factor, and there is, thirdly, the direct influence of light.

As regards the latter, I may quote an observation made by me in South America. I happened to be watching a green tree-frog in the sunlight and admiring the extraordinarily perfect agreement between its colour and that of the surrounding leaves. Across its back fell a dark narrow bar of shadow caused by a blade of grass close by. When I caused the tree-frog to change its position it appeared, to my astonishment, to carry the shadow with it, the position where it had been remaining for some little time clearly indicated by a dark band across the green surface. That observation served to impress upon my mind very vividly the fact of response by the skin chromatophores to localised light stimulus, and while such responses may turn out to be complicated reflexes involving the central nervous system, it seems to me simpler, until convincing evidence to the contrary is produced, to regard them as direct cellular reactions to changes in the incidence of light rays.

J. GRAHAM KERR

The University, Glasgow,
December 22.

Muscular Action.

DURING the last few years a considerable number of papers have appeared bearing on this subject. They may be divided roughly into two classes, the first dealing with the fatigue caused by muscular action, together with the nature of the accompanying waste products, the second, with the behaviour of isolated muscles under the action of artificial stimulus.

From a mechanical point of view, a muscle is a single-acting engine which can exert a pull but not a thrust: and with regard to any class of engines, some of the most important questions which can be asked are: What is (1) their efficiency; (2) their weight for unit of power; (3) how does the efficiency vary with the rapidity of the stroke (*i.e.* piston speed); (4) how do these quantities vary with absolute size? The physiologist may further inquire: (5) What is the nature of the nervous stimulus and how does it effect the required longitudinal contraction and lateral dilation of the muscular fibres? Electricity will act as a stimulus, but (6) is it certain that nervous stimulus is of the same nature? (7) Does an excised muscle behave in the same way as the muscle in a living animal?

Striped muscle wherever met with—from mammal to insect—varies very little in appearance or in the cross-section of the individual fibres. (8) Is the contractile force which can be exerted by each fibre the same or nearly the same in all orders?

These questions are not answered by any of the papers to which allusion has been made.

In a letter which appeared in NATURE of April 15, 1920, I said. "When muscular force is exerted, power is expended and fatigue is produced, even when the muscle remains stationary. Again, when no external force opposes the contraction of the muscle, physiological causes set a limit to the speed at which contraction can take place. In both cases the whole power

expended is lost in so far as the production of useful work is concerned." [1] For the maximum nervous stimulus the acceleration is limited by the mass of the muscle itself and of those parts or limbs to which it is attached and which must move with it, and the greatest contractive force will act when the muscle is stationary, the whole of the power again being lost by muscular leakage. Between these limits there must be a "most economical speed," *i.e.* a speed which will develop the greatest useful power.

If it is assumed that the leakage is proportional to the tension of the muscle, and is the same for the same tension whether the muscle is stationary or in motion, and also that all the work done in internal acceleration is lost (assumptions which should be the subject of experiment), the most economical speed is that which makes the losses by leakage and acceleration equal. If the operation of the muscles is periodic and is associated, as for example in walking, with a natural gravitational period, part of the acceleration is done by gravity, and the muscles only supply as much as is required to convert the natural period to the period of the step—that is, to convert a free period T_1 into a forced period T_2.

A simple experiment which will show the difference between the power required to maintain the forced and free motions may be made as follows. Crossing the arms so that the wrists are in the same vertical plane, make each hand describe a circle about the line joining the elbows and note the rate of revolutions which can be sustained. Here there is no external work to be done, and, since the average position of the forearms is horizontal, the natural period is infinite. Various muscles, however, must act periodically to balance the centrifugal force. Next place both wrists in a looped strap which will form a wrapping connexion between the arms. This will not interfere with the orbital motion, but the centrifugal force will be taken wholly by the strap, and the forced period may in consequence be any imposed period.

With this arrangement it will be found on trial that for the same sense of fatigue the rate of revolution is more than double that which could be reached when the hands were free. The only work done when the strap is in use depends on the small tangential force required to overcome the viscous and leakage losses.

If there were any direct method of measuring fatigue, experiment on these lines would afford a quantitative measure of the relation between the power spent in leakage and in acceleration.

As regards the behaviour of isolated muscle, H. S. Gasser and A. V. Hill give an account (Proc. R.S., B, vol. 96, p. 398) of experiments on an excised muscle fixed at one end and at the other attached by a thread to a balanced beam the moment of inertia of which was adjustable. The muscle was stimulated by a brief current from an induction coil, and the movements of the beam were observed and recorded.

It is not stated whether the same muscle was used in all the experiments, but it may be gathered that each specimen, if there were more than one, was used many times.

It can scarcely be imagined that a muscle deprived of blood supply can continue to perform work, unless that work is supplied by the stimulating current, but the amount of the electrical work is not given. If, however, the work done by the muscle is merely the equivalent of that supplied by the coil, it would indicate that nervous and electrical stimulation differed in kind, for nervous stimulation seems to act much as an igniter does on a charge of powder, that is, to call up power inherent in the muscle.

It would be interesting to have these experiments repeated in a somewhat modified form. Instead of acting on a massive beam, let the muscle turn a wheel by a ratchet and pawl against a resistance controlled by a brake (these need not weigh more than two or three grams) and let the stimulus be applied periodically. Let an automatic record be provided for the stroke, the brake force, and the electric energy consumed in stimulation, and let the experiments be continued for considerable periods (minutes or hours if necessary). In this way a comparison could be made between the work supplied and the work performed.

A. MALLOCK

9 Baring Crescent, Exeter,
December 22.

[1] In this letter an analogy was suggested between muscular action and the working of an engine with a leaky cylinder. The supposed action would also be indicated if a cord, loaded with a certain mass, the motion of which was opposed by a viscous force, had one end attached to a wheel and brake, while the other was fitted with a hand-grip, which, when tension was applied, would slip at a speed proportional to the pull. Here the turning of the wheel would be a measure of the useful work done, and the slip, of the muscular leakage. If the applied tension was less than the brake resistance the cord would not move, but work would be done by the slip, and if the tension is greater, the mass will be accelerated until its viscous resistance plus the brake resistance is equal to the pull applied.

Constant Differential Growth-ratios and their Significance.

ON Mr Julian Huxley's very interesting results as to the fiddler-crab (NATURE, December 20, p. 895), I suggested at Cambridge that in his equation $y = bx^{1.61-1.64}$, if we are to rationalise the index, $y = bx^{\frac{1}{2}}$ comes nearer to his results than does $y = bx^{\frac{2}{3}}$, and allows of the conceivable physiological explanation that the ratio of claw-weight to body-weight is the isogonous ratio multiplied by a ratio proportional to a growing area in the body. Thus the weight of the claw might be the isogonous weight multiplied by the ratio of an isogonous surface secreting a male hormone to a surface secreting a female hormone and remaining of constant area. I also pointed out that in the roe of the plaice we have a sexual appendage, shed every year, and every successive year showing an increasing rate between its weight and the weight of the body. The parallel proves so astonishingly close that I ask space to communicate the following two facts.

(*a*) Representing the weight of the ripe roe of a plaice as y and the weight of the gutted body as x, then, in plaice of different weights

$$y = bx^k,$$

as Mr. Huxley discovered for the claw of the fiddler-crab. The ration of ovary-weight to body-weight has no relation to age, but only to body-weight, in this, as in some other respects, the age of a plaice is not measured by years but by the quantity of food which it has succeeded in assimilating.

(*b*) In the above equation, from the small sample of data at my disposal, I make

$$k = 1\cdot58 \pm 0\cdot10$$
$$-\log_{10} b = 2\cdot610 + 3\cdot063(k - 1\cdot58).$$

This preliminary investigation has been on data which Dr. Wallace kindly gave me at Lowestoft in 1906 from his manuscript notes (9 fishes, gutted weight 429 to 1800 grams, age-groups IV. to XIV.) and some published by Fulton (vol. ix. p. 263; 5 fishes, weight 1280 to 2145 grams, age-groups VIII. to XVI.). They are insufficient to determine with certainty whether or not k varies with increasing weight; on the whole the most probable conclusion from the data is that k is constant. Since Dr. Wallace's figures include only two fish more than 1100 grams, and Fulton's smallest fish is 1190 grams, it is impossible to test directly the similarity of the two groups; but taking the centre of gravity of the logarithms for the ovary and body-weights of

the three fishes under 700 grams, the line joining this to the centre of the remaining 11 fishes gives $k = 1{\cdot}610$; while the line joining it to the centre of only the 6 larger Lowestoft fishes gives also $k = 1{\cdot}610$. The figure 1·58 has been adopted as giving for the fourteen fishes the lowest average error, 0·0512, in the resulting deduced $\log y$; but the average error with $k = 1\ 500$ is only 0 0553, and with $k = 1{\cdot}667$ is 0 0536, so that the $\pm 0{\cdot}10$ seems to indicate the probable extent of our knowledge (With $k = 1\ 75$ the average error is 0·0626, and with $k = 1\ 25$ it is 0 0781. It must be remembered that logarithmic plotting imparts an illusory aspect of accuracy; errors of 0·051 and 0·078 in $\log y$ represent errors respectively of 11½ per cent. and 20 per cent. in the weight of the ovary.) Further investigation of the extensive data by now available from the North Sea Investigations seems best left in the hands of those expert in the history of the statistics and in the natural history of the material It would be instructive to know whether the increase in ratio of ovary to body-weight means a disproportionately large number of ova, or an isogonous number of ova of increased size? If an "area" really determine the ratio, does it secrete, in plaice or in crab, a hormone promoting cell-division, or promoting cell-growth?

The most interesting question now is whether the fact that $k = 1{\cdot}6 \pm 0\ 1$ in fiddler-crab's claw and plaice's ovary be a chance coincidence, or whether Mr Huxley's index, as well as his law of growth, be found to hold good in yet other animals?

I would urge that the latter suggestion cannot be negatived except by investigation of organisms living in the water The index of the stag's antler would not necessarily follow the same law, for as a terrestrial animal the stag is under the necessity of a waning annual coefficient of bodily growth, since its size must not exceed the size which its legs are adapted to carry. Plaice add approximately an equal weight every similar year; for though the size of an aquatic animal may be limited by the size of its food or of its enemy, it is not affected by conditions of mechanical support. An average man is 5½ feet high, but there is no average length for a plaice; the plaice which is ten times the age of sexual maturity will be a longer fish when she is eleven times that age.

It seems possible that this necessity for a waning coefficient of growth may be the explanation of our death. Our growth-rate wanes very slowly to the zero point at 27 years old, but it does not stop waning when zero is reached. Except for creatures whose life is ended by the winter or summer, and those that perish with the act of reproduction, I do not remember any evidence of a marine animal dying a natural death, as we use the word of ourselves. It is natural for every fish to have life ended by the fangs or jaws of his fellow-creatures; in the waters, is any other end natural? Did old age and death only become the necessary fate for plants and animals when they left the swamps, claimed the land, and attempted swiftness or tallness in a medium 1/800 of their specific gravity? If this be true, it was for proportionment of weight to transverse section that we were compelled to renounce the gift of eternal growth, and to accept death.

GEO. P. BIDDER.

Cambridge, January 5.

On the Efficiency of the Petersen Grab.

THE Petersen Grab is now being much used in various parts of the world for the purpose of picking up a portion of the sea-bottom—where this is soft enough—along with the animals of all kinds contained in the surface layer of that portion of the sea-bottom. When a sufficiently large number of samples can be taken on a homogeneous stretch of ground the grab-samples are made a means of determining quantitatively the average distribution of the sedentary population of that area.

In the earlier illustrations of the instrument, as used by Petersen, two types are shown. One of these types appears to be in general use to-day, and is regarded by the present writer as inefficient, while the other, which appears to have gone out of use, is more efficient in principle, and by a slight alteration can be made reliable in practice.

During a recent survey of the oyster beds in the Fal Estuary, the present writer employed the Petersen grab, but came to the conclusion that the current form of grab was inefficient for the determination of an oyster population; and further, that on grounds



FIG. 1.—Peterson Grab modified to cut into a rectangular surface of the sea-bottom and to ensure partial protection of the gap present during closure. (From a photo by Mr. A. J. Smith.)

in which the grab cannot dig, and probably also to some extent even on soft grounds in shallow water, the grab will not pick up with certainty the extent of surface of the sea-bottom which it is supposed to do. The grab consists essentially of two very nearly quarter-sectors of a cylinder hinged along the axis of the cylinder. When the instrument is closed it has the form of very nearly half a cylinder. The occluding edges of the sectors are very nearly radii of the cylinder end section, and their peripheral ends are separated by a chord of about 36 cm. in the open condition of the 1/10 sq. metre type, in which the diameter of the imaginary cylinder is about 45 cm. The occluding radii of the sectors of this type are only exposed in about 16 cm. at their peripheral end, as a central small metal cylinder of about 12 cm. in diameter is built into the instrument around the main axis. The instrument is closed by a vertical pull on a chain, which passes over a pulley on the inside of one sector and is attached to the inside of the other (Fig. 1). In use the instrument is allowed to run freely and arrive on the bottom with a bang; the check on arrival being utilised to release the chain used for closing and hauling.

It follows from the construction of the grab that, in the act of closing, the gap in the semicircular ends tends to become higher and reach a maximum height of about 15 cm from the line joining the peripheral ends of the occluding sector radii This gap in the instruments at present in use is unprotected, and since the portion of the sea-bottom taken in the instrument cannot slide freely into the cavities of the sectors due to internal obstructions and friction, the captured soil tends to pile up under the middle of the instrument and opposite the gaping ends Consequently, there is grave danger of a portion of the surface with its contained animals becoming lost by being pushed out of the grab at the final closing strokes. The loss of soil from this cause is no doubt greater on muddy grounds than on sandy ones, but has nevertheless to be reckoned with on all types of grounds

It follows, therefore, that quantitative estimates of animals in the sea-bottom made by using the type of grab described are in all probability too low In using the grab for quantitative estimations of oysters, the loss of a single oyster from approximately one square foot of ground is a very serious error, and the instrument was quickly altered to the type shown in Fig 1 by bolting thin steel plates to the sides of one sector, so that when the grab touched the bottom it actually cut into a rectangular piece of soil This modification is, however, still open to objection where animals living *in* the soil are being sought for, and the type of grab which will pick up a definite portion of the bottom soil with certainty is one the end plates of which form a complete semicircle In such an instrument the end plates would cut into the soil before the sector jaws reach it, and protect the gap during the whole of the closing operation

J H ORTON

Marine Biological Laboratory, Plymouth,
December 24

The Nature of the Contractile Vacuole.

FOR some years we have been investigating the cytoplasmic bodies in the protozoa In NATURE of March 10, 1923, we were able to give the first account of the stages undergone by the Golgi bodies in the sporozoon Adelea. A full account of this work has been published in the *Q J M S*, vol 67, Part III, 1923 More recently M Ph Joyet-Lavergne (*Comp rend*, 1924) has described the Golgi bodies in *Aggregata Eberthi*, and *Adelina dimidiata*, confirming our account.

For some time our attention has been given to an examination of the Ciliophora and Rhizopoda, in which we have failed to discover anything which we can satisfactorily homologise with the Golgi apparatus of the metazoon

Now, however, Dimitry Nassonov, in the *Archiv f mikr Anat u Entwick*, Oct. 1924, publishes a large paper in which he seeks to homologise the contractile vacuole of the protozoon with the Golgi apparatus of the metazoon.

Nassonov, by means of osmic acid technique, has succeeded, as we have done in our material, in blackening the cortex of the contractile vacuole and the canals leading to it. He claims that this osmiophile membrane has the property of secreting an osmotically active substance into the lumen of the contractile vacuole, and also itself has the distinctive character of a semipermeable membrane

Furthermore, Nassonov gives several reasons for homologising the Golgi apparatus of the metazoa with the contractile vacuole cortex of the protozoa — first, both organellæ are not visible *in vivo*, second, their morphology is similar, both being bladders with an osmiophile wall, third, the sponge (the metazoon nearest to the colonial protist) has a Golgi apparatus which looks like a contractile vacuole, and finally, the Golgi apparatus of the metazoan cell also has the power of secreting various substances

In the first place, Nassonov has shown that the cortex of the contractile vacuole has the power of reducing, and of becoming blackened by, osmium tetroxide We agree fully, having succeeded ourselves in blackening this cortex in a number of ciliates We are also not unprepared to accept some of his interpretations as to the function of this lipoid membrane

When, however, we come to the homology of the metazoan Golgi apparatus and the protozoan contractile vacuole, we feel, at present, that there may be some grounds for doubt The Golgi bodies in embryonic or undifferentiated metazoan cells are almost invariably associated with a centrosphere and centrosome In the ciliates no relation between the contractile vacuole and any body similar to a centrosome can be demonstrated The centrosphere in metazoan cells is never, to our knowledge, a bladder-like structure, the sponge Golgi apparatus lies around a centrosome, from which the flagellum arises, and there is no evidence that the centrosphere in sponge cells is more fluid than the rest of the cytoplasm—but quite the reverse

The line of evidence that both the cortex of the contractile vacuole and of the Golgi apparatus are not visible *in vivo* need not detain us

Similarly, the view that the cortex of the contractile vacuole and the Golgi apparatus have similar powers of secreting substances, is not one of much value The whole discussion comes down to the fact that the metazoan Golgi body, and the cortex of the contractile vacuole, both have the power of reducing osmium tetroxide There are a number of lipoid substances which share this power, and much attention should not be given to this faculty alone

Coming down from pure hypothesis to facts, what we know at present is this a perfectly normal Golgi apparatus has been shown to exist in certain Sporozoa —in Adelea, Coccidium, Aggregata, Adelina, and Haplosporidium. The methods used for this demonstration have not succeeded so far in revealing a similar structure in any ciliate, though the contractile vacuole cortex can be blackened by osmic acid In this laboratory we have tried amœbæ, and many ciliates both free living and parasitic, and we have come to the conclusion that a Golgi apparatus probably does not exist in the Ciliophora and Rhizopoda examined by us.

Finally, we prefer to believe that the Golgi apparatus arose in some primitive flagellated organism in direct association with the blepharoplast.

J BRONTÉ GATENBY
SHAN D KING

Trinity College,
University of Dublin

The Interaction between Silica and Electrolytes in its Relation to Theories of Soil Acidity.

IN a note to NATURE (Dec 2, 1922) some experiments were described in support of a theoretical explanation advanced in an earlier paper (*Phil Mag*, vi 44, 338-45) regarding the nature of soil acidity. Joseph and Hancock (T 1923, 123, 2022), however, state that "pure silica produces no effect on a solution of an acid," and that the adsorption we reported "would not be observed if the silica were more highly purified." We have since repeated our experiments

with hydrated silica (obtained in three different ways), which was purified with the greatest care We have been able to confirm our previous observations that hydrated silica adsorbs acids and that electro-osmotic experiments show that anions are preferentially adsorbed, but we have also found that the samples of silica we used before contained alkali, and gave a much higher value for the amount of acid adsorbed The adsorption of oxalic acid can be very easily demonstrated in view of the simplicity with which it can be volumetrically estimated 10 gm. of air-dried hydrated silica obtained from the hydrolysis of pure silicon tetrachloride can retain, even after repeated washings, oxalic acid equivalent to 10 c c of N/100 permanganate solution

It has been suggested by the writer (Trans Far Soc., vol 18, part 3, p 316) that the increase in P_H of the drainage water from Dartmoor may be attributed to the adsorption of acids by the siliceous beds over which the water passes It is quite easy to demonstrate in the laboratory that a solution of hydrochloric acid, after filtration through a Gooch crucible of fused silica containing air-dried hydrated silica (from silicon tetrachloride), immediately shows an increase in P_H, amounting to more than one unit, indicating a diminution in concentration of more than 90 per cent (*e g* from 3·4 to 4 6)

It has also been stated by Joseph and Hancock that interaction between silica and salt solution is of a chemical nature, as the residue gives an alkaline reaction on removal of the salt It appears to us that this is not the only possible way of accounting for the production of the alkali (cf "Adsorption by Sugar Charcoal," Bartell and Miller, J Amer Chem. Soc , 44, 1922, 1866 , 45, 1923, 1106 , 46, 1923, 1130)

Attention may be directed to the fact that the concentration of the acid liberated by a potassium chloride solution of definite concentration depends on the relative amounts of silica and solution, as also on its previous history. It would appear from the observations of Joseph and Hancock (*loc cit* p 2023) that whereas a sample which has been previously treated with hydrochloric acid gives an extract having a P_H value equal to 3 96, samples which have not been treated with acids give extracts having P_H value equal to 5 33 (or 5·55) under identical conditions The variation in concentration of the hydrogen ions of more than twenty times is extremely difficult to explain in terms of a chemical reaction We would also like to mention the observations of Jordis and Kanter (*Z anorg Chem* , 35, 20, 1903), who, from the difficulty in removing the last traces of hydrochloric acid from silica, concluded that silica forms traces of a complex acid similar to hydrofluosilicic acid.

Further experiments with precipitates like barium sulphate show perfect analogy with the reactions we have observed with silicic acid In these instances, possibility of a chemical interaction between an acid and a neutral salt is very remote In this connexion an interesting observation may be recorded, which to the writer's knowledge has not been recorded before If barium sulphate is precipitated from the interaction of solutions of potassium sulphate (P_H = 6·8) and barium chloride (P_H = 6 6), the liquid shows either an alkaline or an acid reaction according as potassium sulphate or barium chloride is in excess. The acidity or alkalinity may be as high as that indicated by P_H values of 2 and 11 respectively. This reaction appears to offer a clue to the elucidation of the nature of " hydrolytic " adsorption.

J N MUKHERJEE.
Physical Chemistry Laboratory,
University College of Science and Technology,
Calcutta, India, November 27.

Helium and Airships.

IN a recent article on the British dirigible programme (NATURE, December 6, p. 842) it is stated " The United States naturally hold for themselves the only supplies of helium . ." Of course, it must be admitted that the United States authorities, ever since 1918, have pressed with vigour the investigation of their resources of helium, its production and use At the present time the two large dirigibles, the *Shenandoah* and the *Los Angeles*, are inflated with helium Processes of repurifying the gas in them have been devised and applied A more efficient and cheaper method of production than the present Linde process has been worked out by the U S Bureau of Mines, and much valuable scientific data have been accumulated.

It should not be forgotten, however, that Prof. J C. McLennan's investigation in 1916–1918 (see NATURE, August 12, 1920, p 747) showed that helium could also be produced in Canada, and an experimental extraction plant was successfully operated in Calgary, Alberta, for a few months until financial support was no longer forthcoming Since that time, the Canadian Department of Mines, in the course of a general investigation of natural gas in Canada, has confirmed and brought up-to-date the facts concerning the helium resources of Canada Although few gases have been found with so high a helium content as the richest American natural gases, it is believed that commercial sources are available To prove this, the re-establishment of an experimental helium extraction plant in Canada is essential In this plant the best process for treating the different types of Canadian natural gas could be determined, and the actual cost of commercial production could be found The helium produced, until such time as it was required by the authorities, would be of great value to supply to the many university and industrial research laboratories throughout the Empire which are needing it for experimental purpose

In connexion with a later paragraph of the same article, referring to the useful life of German airships and the interest with which the progress of the *Los Angeles* (ZR3) and the new British craft will be observed, no reference is made to the great success already obtained with the helium-filled *Shenandoah*, which has now been in commission since the summer of 1923 In this period it has made many long voyages, including one transcontinental trip of more than 9000 miles Although torn from its mooring mast with the framework damaged and two gas bags ripped, during a severe storm in January 1924, it eventually returned to its hangar A hydrogen-filled ship subjected to the same conditions would probably have been destroyed. R T ELWORTHY

Mines Branch, Dept of Mines,
Ottawa, Ont , Canada.

Molecular Dimensions of Celluloid.

MAY I amplify and comment upon Mr Garnett's letter in NATURE of January 10, page 51 ? I have often been impressed, more particularly during the last few months in collecting material for a small book on cellulose ester solutions, with the want of precision shown by physicists in defining the material used in experiments on nitrocellulose and its technical derivatives. Two eminent examples will suffice. My friend Prof. Coker entitled a most important paper, which he published in collaboration with Mr. Chakko, " The Stress-Strain Properties of Nitrocellulose and the Law of its Optical Behaviour,"

whereas the material on which his experiments were carried out was xylonite or celluloid containing at least a fifth of its weight of camphor and rather more than that proportion of camphor by volume (Phil Trans, A, vol 221, pp 139-162) Another old friend and teacher, Prof Filon, in a paper which he and Mr. Jessop published on the stress-optical effect in transparent solids strained beyond the elastic limit (Phil Trans, A, vol 223, pp 89 125), after deducing the existence in xylonite of a mixture of two materials with different elastic and plastic properties (page 112), speaks in his summary (paragraph (2), page 123) of "nitrocellulose under simple tension" The distinction between xylonite and nitrocellulose in this relation is really important, as it is probable that the elastic and stress-optical properties of nitrocellulose alone would be markedly different from those of xylonite

Mr Garnett refers to celluloid as the basis of photographic film. This is true, but photographic film is quite different in its composition from celluloid in the more massive form, such, for example, as was used by Prof Coker and Prof Filon Not only is the nitrocellulose in celluloid film more highly nitrated, but the proportion of camphor is smaller Even celluloid film, however, does not contain nitrocellulose so highly nitrated as to correspond with what used to be called cellulose trinitrate. This would contain 14 1 per cent of nitrogen, while the nitrocellulose in cinema film usually contains from 12·0 to 12 5 per cent of nitrogen Lastly, having supervised the manufacture of a certain amount of a substitute for celloidin during the War, I should naturally agree that it is a carefully purified product, but I should not like to say that it approaches to a single chemical substance

The analysis of celluloid, provided the camphor used in its manufacture is optically active, is not exceedingly difficult and can be carried out with moderate accuracy, and it would add greatly to the ultimate value of physical measurements made with the material if its composition were always given In the instance which forms the subject of Mr Garnett's criticism, one would like to know not only the chemical characteristics of the nitrocellulose used, but also as many physical properties as possible, more especially perhaps the fluidity-concentration curve in two or more chosen solvents. It is greatly to be desired that all researches on colloid materials should seek to correlate at least two different properties.

FOSTER SPROXTON
The British Xylonite Company, Limited,
Brantham Works, near Manningtree,
Essex, January 13

The Need for a Universal Language.

I READ President Coolidge's address and Prof Gardner's letter on this subject in the *Times* of November 21, 1923, and, now, your report of Prof R G. Kent's article (NATURE, January 3, p. 23), with interest, but there are two points connected with the matter to which attention may usefully be directed. One of the principal causes of the neglect of Latin and Greek in schools is the world-wide recognition of the importance of a knowledge of the so-called "modern languages." This is a blind argument It is as if a student, desiring to acquaint himself with the contents of the top shelves in a library, deliberately ignored and neglected the ladder by which they are reached, and tried to get at them by jumping. Those who are old enough to have been at school in the days of compulsory Latin and Greek amply realise the enormous value of even an almost forgotten grounding in the classics, in the acquisition of any foreign language—this point requires no labouring I wish to point out the great value of having at some time been taught the phonation of an unfamiliar text, like Greek, when one comes in later life to study any Oriental language—or, for obvious reasons, Russian The mind is no longer terrified by the aspect of unknown characters, and thus the first great, and often repellent, difficulty is recognised as being really of little account

A still more important point arises in connexion with the periodically recurring agitation for a "Universal Language" The obvious fallacy of founding such "languages" as Volapuk, Esperanto, Ido, and the others upon the native language of their protagonists requires no argument The result is that each country pleads for its own universal (?) language, and we are back again where we started from

But Latin is, and always has been, *the* universal language Its claims are fully set forth in the report of the Committee of the British Association (1921, p 390). I cannot, however, agree with the "Conclusion" of the Committee Down to, and even in, modern times, knowledge intended to be of world-wide distribution has been, and is, conveyed in Latin —and the worse the Latin is, the easier it is to understand. I am not one of those who plead the rarefied joy of reading the great Latin authors in the original tongue—we have not the time, and existing translations are amply satisfactory—but we do want a language of universal intercommunication, and the appalling Latin of the Roman Church (cf the Bollandists' "Lives of the Saints") is entirely sufficient for the purpose I have proved this in many obscure corners of the world, using a doctor, chemist, priest, or librarian—any one in a black coat, in fact—as an interpreter

If this were once realised and recognised, I see no reason why within a short time one may not ask of any wayfarer in a Magyar town

"Quae est via ad vapor-stationem?"

And receive the reply "Primus ad dextram et tunc tertius ad sinistram"

Atque Felix semper ambulabat.

(O, Shade of Arnold!)

EDWARD HERON-ALLEN
33 Hamilton Terrace, N W

Balfour Stewart's Advances in Radiation Theory.

THE extremely interesting notes by Sir Arthur Schuster in a recent number of NATURE (January 17, p 87) may possibly leave with the ordinary reader an impression that Balfour Stewart's contributions to the establishment of the laws of natural radiation were slighter than was actually the case The considered opinion of the late Lord Rayleigh, set out in *Phil Mag*, 1 1901, pp 98-100, or "Scientific Papers," IV. pp. 404-5, can hardly be gainsaid. In Stewart's discussion of radiation in an isolated enclosure containing moving bodies, his expressed conviction, that the second law of thermodynamics is only satisfied through the action of mechanical forces necessary to maintain the motion, is only turning round the other way the considerations employed by Boltzmann and by Wien long after, who by means of these mechanical forces (namely, the reaction of radiation pressure) combined with the second law of thermodynamics, deduced the law of structure of natural radiation. Reference may also be made to footnotes appended to the reprint of Stokes's cognate papers in "Math and Phys. Papers," IV especially p. 136

JOSEPH LARMOR.
Cambridge, January 16.

The Tsetse-Fly Menace in Tropical Africa.

By Major A. G. CHURCH, D.S.O., M.C.
(Member of the East African Parliamentary Commission).

THE inauguration of a campaign against the tsetse-fly in Tropical Africa is long overdue. Tropical Africa is becoming progressively important as a source of food-supply and raw materials for the Eurasian and American nations The world at large, therefore, cannot contemplate with equanimity the domination by "fly" of a large proportion of the most fertile lands in the tropics. What is most disquieting, moreover, is the fact that the area under "fly" is increasing and not diminishing Hitherto, no colonial government has either had the means or has considered it worth while to adopt methods for its extermination like those employed by Gorgas in the Panama Canal zone against the mosquito Yet, in effect, the ravages due to glossinæ are, in some respects, more deadly than those due to anophelines Malaria has been largely robbed of its former terrors It can be prevented and cured But up to the present no certain preventive remedy has been found for human sleeping-sickness and animal trypanosomiasis, although cases of sleeping-sickness have been cured by atoxyl, Bayer "205," or tryparsamide

From reports supplied to the Parliamentary Commission by the scientific staffs of the five East African territories, Northern Rhodesia, Nyasaland, Tanganyika, Uganda, and Kenya, it appears that the fly-belts are continuous from the Egyptian Sudan to Southern Rhodesia Two-thirds of Tanganyika are under "fly," and this area is increasing owing to the encroachments by fly over the contiguous cultivated areas.* Fly areas which a few years ago were confined to the north-eastern district of Northern Rhodesia now extend as belts through Nyasaland to the lake and make the southern and northern movement by land of cattle from the important district of Mombera an impossibility Most of the islands on Lake Victoria Nyanza are depopulated, some compulsorily as in the case of the Sese[1] islands, others voluntarily, owing to the ravages of sleeping-sickness.

The members of the Parliamentary Commission, on their journey from Dar-es-Salaam along the central Tanganyika Railway, were struck by the desolation of a long stretch of country between Kazi-Kazi and Tabora, a country which was formerly thickly populated. Along the eighty miles of road from Tabora to Kahama men and women passed in procession carrying head-loads of ground nuts to Tabora market, primarily due, not to the conservatism of the native, but to the impossibility of using ox-wagons in a fly district. The following day they passed along thirty miles of road approaching Shinyanga without seeing a native or a head of cattle, although the route lay through a district of exceptional fertility Half the journey from Shinyanga to Mwanza provided the same melancholy testimony of the disastrous effect of tsetse In one sultanate in this district the population has gone down from thirty thousand to three thousand in the past few years, due entirely to the destruction of cattle by this insect pest. For the natives, who still measure their wealth by the number of cattle they possess, will not remain in a district where the cattle die. Mr. Swynnerton, Chief Game Ranger to Tanganyika Territory, states that the fly is known to have advanced in seven places in one district during the past year The largest cattle area in Tanganyika Territory is threatened by the advance of *Glossina swynnertoni*.

It is, however, not merely the destruction of cattle, but the effects which such destruction has upon the natives themselves and the country, which are now causing the gravest concern to the authorities Major G. St J Orde Brown, an administrative officer with years of experience, attributes to this agency the degeneracy and degradation of the north-eastern branch of the Yao tribe compared with the main tribe The loss of their cattle has led to the breakdown of tribal customs and the decline in their morality There is another serious factor which must be taken into account The lines of communication for the greater part of East Africa must necessarily pass through fly areas. For some years at least the economic products must be carried over roads. At the present time most of the roads are unfit for motor transport The use of ox-wagons becomes, therefore, a matter of first importance, but at present their use is circumscribed by the fly-belt. In the past two or three years there has been a remarkable increase in the productivity of the native in most parts of East Africa. If this is to be maintained, the districts through which the roads pass must be cleared of fly; for the present method of head porterage is totally inadequate, and traders are already complaining that their up-country stores are filled to overflowing.

It must not be imagined that this problem has not been viewed with the gravest concern by medical and veterinary officers on the spot, or that the home authorities are not aware of the menace of the tsetse-fly. The work of Sir David Bruce is well known So long ago as 1902 the Royal Society sent out a commission to investigate trypanosomiasis. Much individual and team work of great importance has been done since then. In 1914, Dr. J. O. Shircore, in a contribution to the *Bulletin of Entomological Research*, formulated a plan for the extermination and control of fly. He showed that the primary fly centres were to be found where moisture and game persisted throughout the year. They were to be found, in other words, where light forest, short grass, open glades, and water existed. Furthermore, from these primary centres the fly extended to secondary centres, and bush cover was essential as a communicating link between primary and secondary centres. He suggested that the secondary centres must first be attacked by cutting off their bush connexions with the primary centres, and that when the primaries had been isolated, wholesale and extensive burning during the dry season should be undertaken on a heroic scale. Unfortunately, the War intervened, and it was not until recently that Mr. Swynnerton's energies were applied to the methods suggested by Dr. Shircore. But Mr. Swynnerton has gone further. There is no ques-

[1] The natives are now being encouraged to return to these islands.

tion about the dependence of the fly upon blood. The further assumption was made that the fly cannot exist without game. Mr. Swynnerton has shown this to be untrue. In the Dar-es-Salaam district there is no game, but there are three kinds of fly known to exist. The fly apparently feeds upon human beings and animals indiscriminately.

Mr. Swynnerton proposes to exterminate the fly by bush burning, and he has already achieved a considerable measure of success in the Shinyanga district. There he was fortunate in obtaining the collaboration of a native chief of character and understanding and energy. Makweia, the chief in question, once convinced of the importance of fly extermination, called his people together and informed them that they were to take part in a campaign against a more insidious enemy than man, that they must discipline themselves and respond to instructions as if they were engaged in tribal warfare With the assistance of fifteen thousand natives, Mr Swynnerton was able to undertake bush clearings by means of burning and cutting on a vast scale, with the result that a large area of country will this year be under cultivation and a hitherto desolated district be re-populated and re-stocked.

In the neighbouring province of Uganda, Drs. Carpenter and Duke, and Mr Fiske, are carrying out research of the greatest importance Only a few years ago, owing to the death of more than two hundred thousand natives of sleeping-sickness, Sir Hesketh Bell removed the remaining population from the lake islands and the lake shores, an extremely costly undertaking and one which has been responsible since for much unrest among the detribalised natives Mr Fiske is carrying out single-handed an entomological survey of Uganda Dr Duke is at the moment engaged upon the important task of classifying human and animal trypanosomes and the connexion between human and animal trypanosomiasis. Dr Lamborn, who has been working in Nyasaland, has for some time been engaged in the task of breeding parasites which attack the tsetse-fly with the object of exterminating tsetse by this measure

It is clear, however, that unless all these territories make a co-ordinated and combined effort to deal with the tsetse-fly menace, the achievements in one territory will be negatived by the indifference in others. It will be useless, for example, to exterminate the fly in Uganda and Tanganyika portions of the Lake territory, if Kenya undertakes no similar campaign in the Kavirondo district Sir Robert Coryndon, Governor of Kenya, has stated that "the leading experts who deal with the problems of sleeping-sickness and tsetse-fly control are servants of Uganda, and there is little organised or encouraged co-ordination or exchange of views between them and their technical colleagues in Kenya and Tanganyika Territory." In Kenya colony, as a matter of fact, there is practically no staff available for work in connexion with sleeping-sickness or animal trypanosomiasis.

There is every indication, however, of a changed attitude. In every territory the Governors impressed upon the members of the Parliamentary Commission the necessity for a co-ordinated plan of campaign in the interests of their territories At the present time the Imperial Bureau of Entomology is engaged in formulating a plan of campaign of research into tsetse-fly problems. It is quite obvious that the problems are so vast as to be beyond the capacity of less than ten men to deal with them As Dr. Andrew Balfour said in an address at the Anderson College of Medicine on October 14, 1924. "We are not yet certain as to whether *Trypanosoma gambiense* and *T. rhodesiense* are the same parasite or different species. We still quarrel over the vexed question of the big game, or perhaps one should say the wild animals, as reservoirs of infection We know precious little about immunity to the disease; we are not at all sure as to the habits of Glossinæ, and we are still trying to discover which is the best drug and how we can best prevent this mysterious complaint" The matter is one of such great importance that it is to be hoped that Major Ormsby-Gore's suggestion, that a large working commission of experts be appointed to undertake the necessary research work in consultation with the men on the spot, will be acted upon Such collaboration must form the basis of any heroic measures for tsetse-fly extermination.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

5. LUDWIG BOLTZMANN (1844–1906).

I DID not know Boltzmann intimately, but can tell of some incidents in his life and quote from passages in little-known publications, which mark his impulsive and vigorous character, and illustrate some features of his personality that would be missed by any one acquainted only with his scientific writings. As a young man twenty-six years old, who had only published one or two minor papers, Boltzmann called on Königsberger, then professor of mathematics at Heidelberg, mentioning incidentally that he had discovered an error in one of Kirchhoff's mathematical papers. Königsberger told him that this was a good opportunity of becoming personally acquainted with one of the great men of the time. "Call on Kirchhoff," he advised. "Lead the conversation to the subject, and explain the nature of his error."

Boltzmann acted with characteristic impetuosity. Within an hour Kirchhoff, who always took a great pride in his accuracy, came rushing into Konigsberger's room in a state of extreme agitation "A most distressing thing has just happened to me," he exclaimed. "A young man, of whom I know nothing, enters my room, and before he has time to shut the door behind him, calls out: 'Herr Professor, Sie haben einen Fehler gemacht!'" I give the tale on Konigsberger's authority.

Boltzmann made his reputation during sixteen quiet years at Gratz, but it was a grief to him that his lectures did not attract a more numerous audience, and he was always looking out for a university where

[1] Continued from p. 127.

budding mathematicians were as plentiful as chemists or lawyers. He went to Munich; next to Vienna, but still not being able to satisfy his ambition he was drawn again to Germany, the country towards which he had strong political leanings. He received an offer of a professorship at Berlin, and I was informed by one in a position to know, that the faculty of science at that University received a series of telegrams and letters, few of the latter being dated, some accepting, some refusing, and no one knew in what order they were dispatched. Ultimately, the negotiations were broken off, and Boltzmann went to Leipzig, but he soon longed to return to Vienna. That University would have welcomed his return, but the Emperor declined to call him back, on the ground that an Austrian subject who had accepted foreign service was disqualified from ever again finding employment in his dominion. Mr. von Hartel—who at the time was Austrian Minister of Public Instruction—told me how for a considerable time he stood helpless between two fires: on one side the insistence of the University which wanted Boltzmann, on the other the obstinacy of the Emperor who remained firm in his refusal. At last von Hartel decided to make a final effort, and asked the Emperor for permission to put a hypothetical question. This being granted, the question put was: "If your Majesty's favourite ballet dancer were to run away, and after a year's absence wanted to return, would you have her back?" The Emperor admitted that perhaps he might.

"I beg to submit," said the Minister, "Boltzmann is to the University what your favourite ballet dancer is to you"

Francis Joseph laughed and gave in.

I do not tell the story merely as an amusing episode, but because the image of Boltzmann's ungainly figure trying to practise ballet steps recalls to my mind the occasions—fortunately rare—when Boltzmann indulged in humorous writing. He had travelled much, visiting America, Constantinople, Athens, Smyrna, and Algiers, and in one of his writings tells us how he had always declined to publish an account of his experiences, but that after returning from a lecturing engagement at the Berkeley University in California, the temptation proved too strong, and an article appeared under the title of "Reise eines deutschen Professors in Eldorado." His jokes are driven into us with hammers. Eating and drinking, followed by drinking without eating, form a favourite subject, because to him—as he says—the most important consideration in travelling is to keep one's digestion right. But he might have spared us the gross and unrepeatable allusions to the poisonous effects of pure water and the boast that his otherwise good memory for figures fails when he tries to remember the number of glasses of beer he has imbibed! The astonishing part of his recital is, however, its want of accuracy In an account of a dinner party given in his honour at the country seat of a wealthy lady near San Francisco, he tells us how it began with blackberries, which were followed by oatmeal: "an indescribable mixture of paste and oats, which might be used for fattening geese in Vienna were it not that the geese would refuse to eat it." The enumeration of subsequent dishes makes it clear that it was really dinner and not breakfast that was meant. On scientific matters also he falls into error, as when he tells the reader that the moons of Mars were discovered at the Lick Observatory.

In great contrast with this heavy and vulgar joking, the other matter contained in the volume of popular writings shows us Boltzmann as a highly cultivated man, enthusiastic about poetry, fond of music, not averse from expressing an opinion on art, and with a leaning towards metaphysical speculations. An article on flying written in 1894 is specially interesting, and the following passage shows considerable foresight:

> "It is scarcely doubtful that a dirigible air-ship would create an expansion of intercommunication compared with which that due to the introduction of railways and steamers is negligible. Our armies of to-day would be as helpless against the dynamite thrown down from flying machines as those of Rome would have been against breechloaders The customs' regulations would either have to submit to unthought-of alterations or to be abolished altogether."

Astonishing, as coming from an Austrian, is the German chauvinism to which Boltzmann occasionally gives expression. It appears in his article on aviation, and in a passage in the description of his Californian journey After criticising the Berlin Academy and expressing regret that, since the death of Helmholtz and other distinguished Germans, American students prefer to study in Cambridge and Paris rather than in Berlin, he adds that the United States, and with it the whole world, will suffer in consequence

On scientific matters his judgment is nearly always fair and uninfluenced by national feeling, at any rate so far as Great Britain is concerned. Here is an example of his style of writing when he is carried away by his subject:

> "A mathematician will at once recognise the authorship of the writings of Cauchy, Gauss, Jacobi or Helmholtz, just as musicians will distinguish between Mozart, Beethoven and Schubert on listening to the first few notes of a composition. Perfect elegance of construction, though occasionally supported by weak foundations, belongs to the French; the greatest dramatic vigour to the English—and above all to Maxwell. Who does not know his dynamical theory of gases? First the variations of velocities are deployed in majestic array; next enter from one side the mathematical conditions and from the other the equations of central motion. Higher and higher rises the chaotic flood of formulæ until suddenly four words resound: 'Let n be 5,' and the malignant demon V vanishes, just as in an orchestra a wild overpowering bass may suddenly be reduced to silence. By a magic wand, an apparently hopeless confusion is reduced to order. There is no time to explain why one or the other substitution is made; let him who does not feel it in his bones put away the book. Maxwell is not a conventional musician who has got to explain his notes; obediently his formulæ deliver torrential showers of results, until we reach the final surprise effect. The problem of the thermal equilibrium of a heavy gas is solved, and the curtain falls. I recollect Kirchhoff's

remark to me: 'This is the way to deal with gas theories!'"

It is not perhaps fair to examine this passage too closely, as a certain amount of poetic license must be forgiven—but Maxwell did not write, "Let n be 5"; he wrote, "It will be shown that we have reasons from experiment to believe that $n=5$." Sixteen words instead of four; but scientific accuracy has no chance when rhetorical effect is in danger, as the late Lord Rayleigh remarked to me when I criticised a statement of a distinguished relative of his.

Shortly after his final return to Vienna, Boltzmann committed suicide. With him passed away a man of great intellectual power and a fascinating personality. His predilection for Schiller's poetry indicates a strain of morbid sentimentality, and if his humour was somewhat primitive and his technique crude, he paid dearly for his disappointments in life.

The Talking Film.

By Dr. E. E. FOURNIER D'ALBE.

THE demonstration of the De Forest phonofilm at the Royal Society of Arts on November 26, 1924, and its recent exhibition at the Royal College of Science during the Physical and Optical Societies' Exhibition, showed that the old problem of producing a motion picture endowed with its original sound effects has been brought within hail of a perfect solution

As Mr. C. F. Elwell remarked in the course of the demonstrations, the De Forest phonofilm was preceded by many partial solutions of the same problem.

The first "talking picture" was known as the "cameraphone"—the method employed being to make the motion picture while a stock wax cylinder type of record was played The actors sang, or pretended to sing, and the camera photographed the lip motion. The novelty of this method made it popular for a time.

The "kinetophone" of Thomas A. Edison was the next step in advance. Better results were obtained for the reason that the phonograph record was made simultaneously with the making of the motion picture negative. The synchronisation of the sounds with the lip motion was good, but the reproduction of this synchronisation was difficult, as so much depended upon the skill of the operator, who generally had another man to start the phonograph record If mechanical or electrical means were supplied it was difficult to keep the phonograph record and the film exactly in step. If a portion of the film became mutilated the difficulties became greater. Notwithstanding these objections the "kinetophone" enjoyed quite a large measure of popularity. But this popularity waned, and finally no more was heard of this method.

It became evident that no solution would be practically workable until a perfect synchronism between sound and movement could be automatically established. It was, therefore, necessary to look for other methods of reproducing sound. Among these the most promising was Ernst Ruhmer's "photographophone" of 1907, in which a "speaking arc" projected light through a slit on to a moving photographic film. The audio-frequency fluctuations of the arc were thus recorded as a series of lines stretching across the film in a direction normal to its displacement, and Ruhmer succeeded in reproducing the original sound by transmitting a beam of light through this record to a selenium cell.

It was a modification of this method which Dr. Lee de Forest used for his talking motion picture. In common with Berglund and other experimenters, he confined the photographophone record to a narrow portion of the standard one-inch film as used in cinema theatres. But his method of producing the record has many original features. He uses a double-button ("push-pull") microphone with a duralumin diaphragm between the two buttons. Such a microphone is capable of carrying 20 milliamperes. It is placed

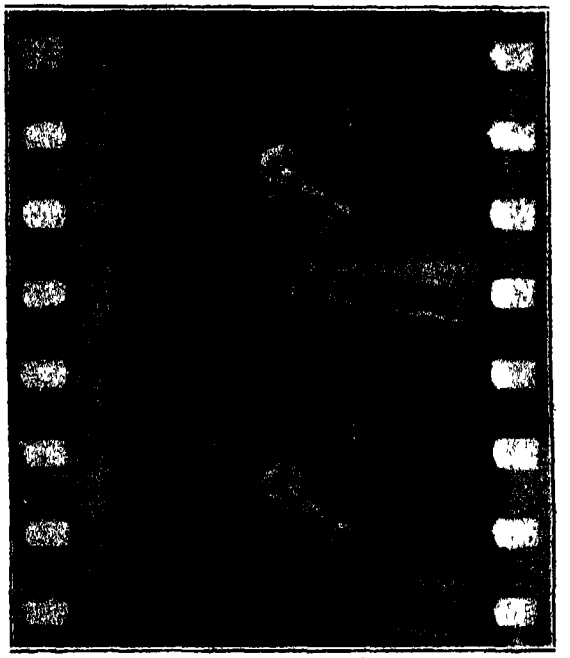


FIG. 1.—Enlarged photo of piece of film showing a banjoist performing. The cloudy strip at the left of the photograph is the music record

about 5 feet from the speaker, and responds to all frequencies from 30 to 7000 per second.

An even better device is a condenser microphone with a capacity of 4 milli-microfarads, which is found capable of a range of 25 to 8000 vibrations per second.

The distortionless amplification of the electrical pulses yielded by the microphone is nowadays a comparatively easy matter, thanks largely to Dr Lee de Forest's own previous inventions.

The next stage is the conversion of the electric pulses into fluctuations of actinic light. This conversion is neatly accomplished by means of a vacuum tube in which an electrode covered with barium dioxide discharges a current of some 5 milliamperes under a pressure of 150 volts through helium at 100 mm. pressure. This vacuum tube is called a "photion." It responds instantaneously to the variations of the

amplified microphone current, and as its glow is of a highly actinic wave-length it produces a well-marked effect upon the film, upon which it shines through a fine slit.

It remains to reconvert the photographic record into sound. For this purpose Dr. de Forest prefers to use photo-electric cells instead of selenium, mainly on account of their more constant zero, though it is difficult to see why that should be of any consequence in the case of intermittent light. Of the various forms of photo-electric cells he prefers T. W Case's "thalofide" (thallium oxy-sulphide) cell, which has a resistance of from 5 to 500 megohms, and works best with some 140 volts on the electrodes.

The moving film passes a fine slit, 0·038 mm. wide and 2·3 mm. long, illuminated by a small incandescent lamp The electric fluctuations produced in the circuit of the photo-electric cell are excessively minute on account of its high resistance, but four or five stages of amplification suffice to enable them to operate a loud-speaker, and the actual volume of sound heard at the demonstrations showed that not much difficulty need be anticipated on that score The remaining difficulty appears to be the distortion introduced by the loud-speaker. Whether that can be entirely eliminated remains to be seen. The rapid progress made in the construction of loud-speaking telephone receivers in recent times gives room for optimism in this direction. In the banjo solo (see Fig. 1) no distortion was perceptible, but President Coolidge's speech was marked by an exaggerated American accent, most of which must have been due to the manner of reproduction. This fact may obtrude itself less upon an American audience than upon Britishers, but if it were to be perpetuated, the vogue of the American film in England would be seriously jeopardised.

It has often been objected that nobody wants the talking film, that silent film acting is an art in itself; that the film has an international appeal, which would be lost by introducing speech and local accent, and that the art and training of even the greatest film "stars" would become useless if the film were to throw off its mantle of silence But the most probable issue is that the talking film will develop its own art and its own industry in its own way, and although it will no doubt evolve its own conventions and limitations, it is likely to win a permanent place among the amenities of civilisation.

Obituary.

Abbé Rousselot.

THE Abbé Rousselot passed away on December 16 last. Born in 1846 at St Cloud (Charente), he was ordained in 1870 and became one of the teachers in the Petit Séminaire de Richemont Leaving his pastoral work on account of his health, he devoted himself to language studies under Brachet, Bréal, and Bailly. He became convinced that "phonetics should take as its basis not dead texts but the living and speaking man" In his peregrinations from parish to parish he became keenly observant of the fact that "sounds change with perfect regularity from one region to another", he came to believe that "phonetics could be something more and better than a descriptive science of spoken sounds, that it ought to be geographical" Noticing the differences in pronunciation among three generations of his own family living together, he got the idea of genealogical phonetics This thought led to the foundation of the science of experimental phonetics

Coming to Paris in 1880, Rousselot was initiated into questions of Romance linguistics by Gaston Paris and Michel Bréal, to the physical sciences by Branley and Becquerel, to physiology by Déjerine, and to fine instrument work by Koenig Finding it impossible to detect the finer details of spoken sounds by the ear, he complained to Gaston Paris, who said, "Only mechanical registration will give you accurate knowledge. Attempts have been made in Marey's laboratory. Go and see!"

In 1886, Rousselot devised an electric speech recorder with which he made investigations of his native dialect. In 1889 the first course in experimental phonetics was given at the Institut Catholique de Paris. In 1891 he obtained his Doctorat ès Lettres before a committee hostile to experiments—the first doctorate in experimental phonetics. He was the inspirer of *La Parole* and later the founder and editor of the *Revue de Phonétique* (1911–1915). His great work, "Principes de phonétique expérimentale," was finished in 1908.

In 1897, G. Paris and Bréal succeeded in founding a laboratory of experimental phonetics at the Collège de France; it was annexed to the chair of comparative grammar (Bréal) and Rousselot was made its director In opening the laboratory, Prof. Bréal did not hesitate to declare that "the moment has arrived when one could no longer think of phonetics as anything else than experimental"; he proclaimed that from now onward "it would be necessary to collect facts instead of announcing *a priori* principles"

In this heroic age, the Abbé and his pupils worked with insatiable ardour at inventing apparatus, developing methods, and collecting facts. They had to face the opposition of the whole world of linguists, grammarians, and philologists, but with ready pens they fired their bombs of explosive facts at the army of opinion and guesswork.

Rousselot had several admirers and friends of the older generation outside France. Foremost among them was the linguist and phonetician, Viëtor of Marburg, who invited Rousselot to lecture there and insisted on introducing experimental methods in a modest way. Under his auspices a phonetic cabinet was established with Calzia, a pupil of Rousselot, as chief. The speech pathologist Gutzmann developed an extensive laboratory on Rousselot's lines in Berlin in connexion with the speech clinic. Coming into phonetics from another side, I had the privilege of spending a few weeks in Rousselot's laboratory in the early days; his spirit and his methods have been the inspiration in all I have attempted since.

Few of Rousselot's pupils have succeeded in following him. The environment has usually not been favourable, and they have seldom had the inspiration that

leads to self-sacrifice for an ideal. The most successful pupil is probably Prof. Calzia in Hamburg, who, in a favourable environment created by Meinhoff, has built up the most completely equipped laboratory of the present day. A favourite pupil, Prof. Chlumski, has now a laboratory in the University of Prag. His latest pupil and assistant, the Abbé Millet, has been appointed to take charge of Rousselot's laboratory.

In establishing experimental or laboratory phonetics, Rousselot's scientific influence has been decisive. In France, laboratory work has been begun at Grenoble and Montpellier Work with Rousselot's methods has also been introduced into the Sorbonne. In Germany, the large laboratory at Hamburg and the pathological speech laboratory at Berlin are based on his methods; smaller beginnings are found in other universities. In the United States I built up an extensive laboratory at Yale University, but the work was dropped after my departure. The demand for this work in that country is now pressing, but no men can be found who have learned the methods In England I have for twelve years conducted researches on speech in nervous diseases, using Rousselot's graphic method, and I scarcely need say that in Vienna the work is based on Rousselot's ideas and methods.

In one way it might be said that Rousselot just lived to see the realisation of his ideal as expressed by Prof Bréal. The adjective "experimental" need no longer be used; there is no other kind of phonetic science. This means that in investigating living speech, all judgments by the ear become quite subordinate to the study of registrations But no one could for a moment think of any antagonism between the phonetics of present-day speech and the science of historical phonetics treating of sound change in the past. In fact, what experimental phoneticians have accomplished in their domain is a small matter in comparison with the magnificent work of past and present linguists. What Prof Bréal meant to point out was probably that when the historical phoneticians wish for explanations of the past facts of sound change, they must seek the sources of similar processes in living speech; this information can be obtained only through experimental phonetics. It behoves experimenters, however, to recognise that in this direction they have been able to advance only a very small way.

Experimental work was begun by men in other sciences, such as Brücke, Donders, Hermann, Helmholtz and others—nearly all physiologists, but the unification of effort into a science was the work of Rousselot. He is fully entitled to be called the "Father of Experimental Phonetics." E. W. SCRIPTURE.

SIR GUILFORD L. MOLESWORTH, K.C.I.E.

THE death on January 21 at the age of ninety-six of Sir Guilford Lindsey Molesworth removes one whose name has long been a household word among engineers. To few it is given to become a leader in his profession, but Sir Guilford Molesworth not only rose to distinction and became the president of the Institution of Civil Engineers, but he also compiled a standard work of reference which has been carried into the remotest corners of the earth. Published first in 1862, his "Pocket Book of Engineering Formulæ" passed through no fewer than twenty-four editions before 1900. A "Molesworth" was to be found in the pocket of practically every engineer, and its pages have been thumbed in many a difficult situation, knowing that its contents could safely be relied on

Born in Southampton on May 3, 1828, nine years before Queen Victoria came to the throne, Sir Guilford was the son of the Rev. J. E. N. Molesworth, vicar of Rochdale, grandson of John Molesworth the mathematician, and was a descendant of the first Viscount Molesworth, created in 1716 He was educated at King's School, Canterbury, and at the College of Civil Engineering, Putney, and then was apprenticed to Fairbairn, the leading engineer of his day. He gained experience in railway engineering on the London and North-Western Railway, and London, Brighton, and South Coast Railway, and during the Crimean War was employed in Woolwich Arsenal. In 1859, at the age of thirty-one, he went out to the East in connexion with the first railway in Ceylon: that from Colombo to Kandy. Three years later he became chief resident engineer of the line, and in 1867 Director of Public Works From Ceylon, in 1871, he passed into the service of the Indian Government as technical adviser on railways and held that position until 1889, receiving the honour of knighthood in 1888 He had seen active service in Afghan and Burma, and after his retirement was employed in various government missions, such as reporting on the Uganda Railway He also became known as a writer on the decimal system, bimetallism, taxation, and other subjects In 1904, at the age of seventy-six, he was chosen to succeed Sir William White, the great naval architect, as president of the Institution of Civil Engineers, and his address contains an admirable summary of the public works of India. Prefacing his remarks by a saying attributed to Macaulay to the effect that "a broken head in Coldbath Fields created greater excitement in England than three pitched battles in India," he reviewed the progress of the irrigation works and the railways of India, and referred to the Indian Government as "the purest administration in the world" Speaking of the resources of India, he said its coal fields covered an area of 35,000 square miles and contained some 20,000 million tons of coal.

A man of extraordinary physical energy, when in Uganda in 1899 Sir Guilford cycled 46 miles on the hottest day of the summer "without experiencing any fatigue," and in the early part of the War, when well over eighty years of age, he served as a skilled mechanic in one of the munition shops of Messrs Vickers at Crayford.

WE much regret to announce the death on January 26, at the age of seventy-one years, of Sir James Mackenzie, F.R.S., honorary physician to his Majesty in Scotland. Sir James will be remembered as a pioneer investigator on cardiac disease, and only recently was awarded the Charles Mickle Prize offered by the University of Toronto for the best work to advance sound knowledge of a practical kind in medical art or science during the past ten years.

Current Topics and Events.

DURING the past week there have appeared articles upon a method of permanently moth-proofing wool, by the use of a substance of undisclosed composition, the product of a German dye firm These were supplemented by a lecture given at Australia House on Friday, January 23, in which the merits of this process were elaborated. The tests made were on wool and furs, large quantities of eggs of the clothes moth being employed upon treated and untreated material under identical conditions. Two forms of treatment are used—one a water-soluble material for goods that can be treated with water, the second, soluble in benzene and suitable for the dry-cleaning process It is claimed that after the water process, dry cleaning will not affect the goods, but dry-cleaning articles already treated by the dry-cleaning method will remove the protective substance. Prof H Maxwell Lefroy has been good enough to favour us with the following comments upon the process. "The nature of the water-soluble substance has been actually known in England for more than a year tests have been carried out in London with this material for eighteen months, and two new classes of moth-proofing substance have been discovered, which have all the merits of this material and in addition are far less costly and far simpler to apply As these are the result of inquiry instigated by commercial interests, it is not possible to disclose their composition, but it is unfortunate that the columns of reputable daily papers should be available for a description of a secret preparation under the guise of 'news,' made by a foreign firm In this particular instance, scientific research in England appears to be ahead of that in Germany but, as usual, has not been backed by resources in any degree comparable to those employed by the firm in Germany now vigorously exploiting a method that has already been superseded. One may anticipate the adoption of the German substance in view of the vigorous publicity and the greater commercial enterprise in such chemical production"

A COMPREHENSIVE scheme for the publication of abstracts of biological research on an international scale has been developed in the United States and has received general support from scientific institutions in that country The proposals were put before the British Association at Toronto last summer, and a committee of the Royal Society is also considering the matter. The subject was discussed at a representative meeting of British zoologists held in the rooms of the Zoological Society of London on January 10, when the following resolution was passed unanimously —"This meeting of British zoologists is of opinion that it is in the highest degree desirable that an effort should be made to extend the system of publishing comprehensive abstracts of zoological literature, and we desire to place on record our great appreciation of the work that has been done to this end by the American Committee for *Biological Abstracts*. We are, however, also of opinion that the scheme that has recently been submitted for our approval is open to serious objection in various directions. Only some of these need here be mentioned, namely: (1) The magnitude of the work involved appears to have been under-estimated. (2) The financial arrangements so far made public are obviously quite inadequate for the purpose, which is a most serious point, it would be folly to assume that any publication of abstracts in pure science can be made self-supporting, and no scheme of this kind should be put into operation until satisfactory arrangements have been made for some permanent endowment (3) The proposal to publish the abstracts of the whole of biological literature in a single journal is unsatisfactory; such a journal would be extremely cumbersome and highly inconvenient for all classes of workers Bearing in mind the probable great increase of literature in the future, a much sounder plan would be to institute separate journals dealing with convenient sections of scientific work (4) The abstracts will be very much shorter than those now being published in this country, and this brevity will seriously detract from their value to most workers (5) The estimates for indexing are entirely inadequate (6) No provision has been made for the utilisation or co-ordination of the various biological abstracting organisations that already exist in this country and deal adequately with several branches of science; apparently it is proposed to reduplicate their work, but in a less useful form In the circumstances we consider that this scheme requires drastic revision"

THE application of science to problems connected with the cotton industry formed the subject of Dr A W. Crossley's discourse at the Royal Institution on Friday, January 23 Nearly every branch of science has its bearing on the cotton industry. Botanically, much work is being done on the structure of the cotton hair itself and its relation to the various processes, such as spinning, that it goes through during manufacture From an engineering point of view, it is extraordinary that no great invention has been made in regard to cotton machinery for more than fifty years, and the British Cotton Industry Research Association has already under consideration important modifications in one machine. At the Shirley Institute laboratories, too, new light has been thrown on mercerisation, for which it has been found there is a definite limiting botanical factor. Much valuable work has just been carried out on problems connected with bleachings Cotton well bleached should be white, but should not have suffered any deep-seated chemical changes such as would affect its physical properties or lower its strength; also bleaching is carried out by means of oxidising agents, and great care has to be taken as they attack the cellulose to form oxycelluloses. Unlevel dyeing may be a result. The chemical tests that are used for determining the extent of this attack have been investigated, and it has been discovered that the slightest change of acidity or alkalinity of the liquor plays an important part. The application of physics has produced a number

of important instruments for testing the regularity of yarns, their resistance to wear and to oscillating tensions, as well as their tension in the loom. In a special regularity tester, the irregularities in a yarn are magnified 18,000 times by a shoe riding over it and a system of indicators and mirrors which produce on a moving bromide strip a photographic record of every minute change of twist and so act as an index to the action of the spinning machinery on the yarn. The doubling twist can also be measured by the instrument Here another important achievement has been attained, for in conjunction with a special photometer which compares degrees of brightness, the right doubling twist that should be given to a singles yarn to produce the most lustrous effect has been discovered

An interesting exhibition of photographs, paintings, and drawings from the third Everest Expedition is now being held at the Alpine Club Gallery, Mill Street, W In addition to views of Everest, the photographs by Capt J B L. Noel show something of the interesting country through which the expedition passed Among them is a photograph of a gigantic figure of Buddha, more than forty feet high, from the Shekar Monastery It is said that within this figure there are stored many thousands of precious stones and other treasures. The oil paintings and drawings by Mr. Francis Helps, apart from their artistic merit, which is considerable, are of scientific value as a record of racial types and costume. They depict Lepchas, Tibetans, and Sikkimese. A portrait of the Maharanee of Sikkim and of a lady in full Tibetan dress are both very effective. The latter wears the full Tibetan head-dress with false hair. A painting of a Lepcha woman has the old costume, now discarded, although the traditional dress of the men, also shown, is retained. There is a very fine representation of a Red Lama in ceremonial dress with striking and strongly marked features. A Bhutia girl with pronounced Mongolian characteristics, while not in itself unpleasing, in the heaviness of the type serves as a foil to the other female heads The artist has shown great skill in catching the differences in type and expression of the various races.

A dispatch from the Cairo correspondent of the *Times* in the issue of January 20 records some noteworthy results obtained by the members of the Boston-Harvard Expedition this season in their excavations on the limestone plateau east of the pyramid of Cheops at Giza. In clearing the Royal Cemetery of the Fourth Dynasty, boat-shaped cuttings were found in the rock foundation of the chapel of Cheops which had served as receptacles for the funereal boats of the dead king and his queens. In one which has been uncovered, the bottom was made to fit the shape of the boat, and one of the slabs of the covering is still in position. The most important find consisted of two small tombs of the Sixth Dynasty belonging to two priests, Qa'ar and Iduw, his son. In the tomb of the former the entrance leads into a hall in which stand five figures each representing Qa'ar in one of his official capacities, with a little figure of his son Iduw. This tomb is of an entirely new type. The tomb of Iduw also contains six life-sized figures, five of Iduw himself and one of his son. On the walls are skilfully carved reliefs which include four scenes of men and women mourning, a subject rare at this period. What is described as the gem of the whole find is a stele of limestone, coloured to represent granite, on the right-hand wall. Starting high up on the wall, it reaches only half-way to the ground The rock beneath the lower edges has been hollowed out to form a rectangular niche in which the upper part of Iduw's body is carved life-size, as if emerging from the rock, with outstretched arms, palms upward, as though in readiness to receive the offerings the priests placed on the offering stone which lies in front It is an astonishing break from the formalism of Egyptian art, remarkable in the Old Empire

In a lecture given in the Royal Exchange on January 20 on the Evolution of the Steamship, to the members of Lloyds' Students' Society, Eng.-Capt Edgar C. Smith, now the official guide lecturer at the Science Museum, South Kensington, suggested that if the members should be ever in need of technical information they could not do better than visit the Science Museum, where they would find models and diagrams in profusion and, moreover, the best technical library in Great Britain. In the course of his lecture, Capt. Smith said that the Science Museum deserves the support of every shipbuilder, shipowner and engineer in the country It is much more than a museum; it is the nation's permanent Palace of Engineering. As compared with similar institutions, the Science Museum may be said to show how men have made their fortunes while the art galleries show how they have spent them It was Sir Richard Tangye, whose first success came with the construction of the hydraulic jacks used to push the *Great Eastern* into the Thames, who gave Birmingham its beautiful picture gallery, while it was Samson Fox, the inventor of the corrugated flue used in marine boilers, who built the Royal College of Music at South Kensington. Bessemer, Hughes, Mond and many others had left large fortunes, but in the matter of legacies the Science Museum had been treated like a spendthrift and cut off without a shilling Though the engineering exhibits at the Museum are in a fair way to be properly housed, the same remark does not apply to the naval collections, and what is wanted now at the Museum is a National Gallery of Ships and Shipping worthy of the greatest port in the world, of the nation itself, and of our glorious heritage of the sea.

The presidential address to the Royal Meteorological Society was delivered on January 21 by Mr. C. J. P. Cave, who took as his subject, "The Present Position of Meteorology and Meteorological Knowledge." The Royal Meteorological Society celebrates its seventy-fifth anniversary this year In looking back Mr. Cave stated that great progress has been made in the past 25 years, largely stimulated by upper air research. Meteorology is at a disadvantage compared with other sciences; the number of posts open to meteorologists is very limited; and support for the Society has to come largely from amateurs.

The Society ought to encourage education in meteorological science But it is not only elementary meteorology that should be encouraged ; there is a vast scope for research in the science , forecasting is only one of its branches, and except in the matter of forecasting, meteorology in Great Britain is the worst endowed of all the sciences. Is it too much to hope that some great company or some public-spirited individual may come forward to endow a chair of meteorology in one of our universities and to make provision for research The Royal Meteorological Society is, so to speak, in a position of trust for meteorology, being the only independent body in the country especially devoted to that science It is true that there is the Meteorological Office, but its position at the present time is an unfortunate one , its future is uncertain In the past the Meteorological Office was directly under the Meteorological Committee, which administered a Government grant. Soon after the War, the Office was placed under the Air Ministry It seems a grave anomaly that the Meteorological Office, which deals with problems of the greatest importance to many Government departments and to many public bodies, should be solely under the direction of the Air Ministry, more especially when there is in the Department of Scientific and Industrial Research a very suitable body under which it might have been placed

SENATOR MARCONI has been elected an honorary member of the Institution of Civil Engineers.

DR. J H JEANS will deliver the sixteenth Kelvin Lecture of the Institution of Electrical Engineers on Thursday, February 5, at 6 o'clock The title of the lecture will be " Electrical Forces and Quanta." At the beginning of the meeting a statuette of the late Sir Joseph Wilson Swan will be presented to the Institution by Mr R K Morcom

APPLICATIONS are invited by the Scottish Society for Research in Plant-breeding for the directorship of research, in succession to Mr. J M F Drummond, who was recently appointed Regius professor of botany in the University of Glasgow The applications, with statements of qualifications and experience (in each case seven copies), must reach the Secretary, 3 George IV. Bridge, Edinburgh, by March 14, at latest

THE British Non-Ferrous Metals Research Association, 71 Temple Row, Birmingham, is inviting applications for three junior research posts, namely, a physical chemist or metallurgist (for work on atmospheric corrosion), a metallurgist or chemist (for the study of the wastage of copper locomotive fire-box stay rods), and a metallurgist with good physics training (for the study of zinc and high-zinc alloys and their workability) The latest date for the receipt of applications is February 9

THE four-hundredth anniversary of the death of Vasco da Gama, who was the first to reach India by the Cape route, and died on Christmas Eve, 1524, is being celebrated at Lisbon. The *Times* correspondent reports that at a reception held at the Palace of Belem on January 24, representatives of twenty-six governments presented their credentials. On January 25 there was a service at Belem Cathedral, and the blessing of the sea at the place whence da Gama sailed.

SIR JOSEPH J. THOMSON has been awarded the Faraday Medal by the Council of the Institution of Electrical Engineers. This medal is awarded not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution The present award is the fourth which has been made

THE Buchan prize of the Royal Meteorological Society was awarded to Mr W H Dines, at the annual general meeting held on January 21 The prize, now awarded for the first time, was recently founded to commemorate the late Dr Alexander Buchan, who did much to advance the interest of meteorology in Scotland and was intimately associated with the work done on Ben Nevis The award was made to Mr W. H Dines for his recent papers on radiation read before the Society Mr. C J P Cave, the president of the Society, in making the award, recalled the pioneer work which Mr Dines had done in the investigation of the upper air before he turned his attention to the problems of radiation

THE Gold Medal of the Royal Astronomical Society has been awarded by the Council to Sir Frank Dyson, Astronomer Royal, for his general contributions to astronomy, and in particular for his researches on the proper motions of stars. The medal will probably be presented at the ordinary meeting of the Society on June 12 At the annual meeting, to be held on February 13, Prof Eddington, Dr Jackson, Mrs Maunder, and Prof Milne will speak on the progress of astronomy during the past year , Prof Fowler and Prof Newall will speak on the forthcoming meeting of the International Astronomical Union at Cambridge , and Dr Dreyer will give a short account of Tycho Brahe's observations, methods, and results

THE National Institute of Agricultural Botany is now prepared to accept entries for its fourth series of yield and quality trials of new varieties of potatoes from breeders who are willing to entrust the Institute with the marketing of their productions on a profit-sharing basis. The trials are planned to last for five years, at first in Scotland only, but in the later years also in the English potato districts Only those varieties which do sufficiently well in the trials will be placed on the market. Full particulars of the conditions of the trials can be obtained from the Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge. Applications should be made not later than February 28.

SCHOLARSHIPS, each of the annual value of 300*l.*, are being offered by the Grocers' Company for the encouragement of original research in sanitary science. There will also be an allowance to meet the cost of

apparatus and other expenses in connexion with the work. The tenure of the scholarships is one year, with possible renewal for a second or third year. Applications must be sent before April 1 to the Clerk of the Grocers' Company, Grocers' Hall, London, E.C.2, from whom a form of application and further information may be obtained.

CERTAIN of the members of the staff of the Rothamsted Experimental Station, Harpenden, Hertford, are available for a limited number of lectures to Chambers of Agriculture and Horticulture, Farmers' Clubs, Agricultural Societies, Farm Workers' Associations, and similar bodies, on the work being carried on at the Station. The subjects include various aspects of manuring and agricultural chemistry, physics and botany, the use of insecticides and fungicides, bee-keeping, and so on. All communications regarding lectures should be addressed to the Secretary of Rothamsted Experimental Station.

ACCORDING to the Report of the Council of the Zoological Society of London for December, the number of visitors to the Society's Gardens in Regent's Park during the year 1924 reached the total of 2,057,146—the largest number in the history of the Society, and an increase of 444,021 as compared with the previous year. The number of visitors to the Society's Aquarium since its opening in April reached the total of 567,936. The number of fellows elected and readmitted during the year 1924 was 876, an increase of 374 as compared with the previous year, and a record never before reached in the history of the Society.

THE collection of antique microscopes, about 400 in number, formed by the late Sir Frank Crisp, Bart., is to be offered for sale by auction at Stevens's Auction Rooms, Ltd., 38 King Street, Covent Garden, W.C.2, on Tuesday, February 17. Catalogues can be had from the auctioneers.

IT has been suggested recently that Messrs. Oertling, Ltd., are importing parts of German balances and merely assembling them in Great Britain. We understand that this is quite untrue. All Messrs. Oertling's balances are manufactured entirely at the firm's works in Turnmill Street, E.C.1.

Our Astronomical Column.

THE SOLAR ECLIPSE OF JANUARY 24.—Preparations were made at Greenwich for observing the first contact by the Innes method with several instruments, but thick clouds interfered. There were frequent glimpses of the partially eclipsed sun, but nothing could be done except to note the change of illumination and of the colour of daylight. The latter changed markedly near greatest phase, the cause, doubtless, being the absorption of light of short wave-length near the sun's limb. There were some beautiful spectral colours on clouds near the sun.

It is very welcome news that the conditions at the Yale Observatory, Newhaven and elsewhere on the east coast of the United States are described as perfect, and the photographs obtained there should be of great interest. The following time determinations of totality are given in the telegrams (the figures are the corrections to the times computed from the almanac data): Yale $+4^{sec}$, Buffalo -2^{sec}, Ithaca $+5^{sec}$, Poughkeepsie $+3^{sec}$, Newhaven $+5^{sec}$, Long Island $+3{\cdot}6^{sec}$, Mean $+3^{sec}$. The almanacs used a correction of $+8{\cdot}0''$ to Brown's longitude (corresponding with $+7{\cdot}0''$ to his mean longitude) but used no correction for the sun which requires about $+1''$, or $+2^{sec}$ in the time of eclipse. Hence it would appear that the correction applied to the moon was within $1''$ of the truth, but perhaps slightly too great.

The country round New York was covered with snow, and the passage of the moon's shadow over this white surface, which was clearly seen, must have been a striking sight. On the whole, the weather in the United States seems to have beaten expectations, which were not high owing to the season.

OCCULTATION AND LUNAR ECLIPSE.—It is worth directing attention to the fact that the occultation of Aldebaran on February 2 is the last (at least for the neighbourhood of London) of the series that have been going on for some three years. It will be followed by a blank period of nearly sixteen years. Disappearance is at $23^h\ 54^m$, 4 hours west of the meridian, and reappearance 53 minutes later. In view of Prof. Brown's appeal, and the facilities for accurate time afforded by wireless, it is hoped that it will be extensively observed.

The lunar eclipse of February 8, lasting from $20^h\ 8^m$ to $23^h\ 15^m$, will be favourably visible in Great Britain, the moon being high up. Three-quarters of the moon's diameter will be obscured, and it may be possible to form some idea of the colour and illumination of the portion in the shadow. These are now believed to depend on the meteorological conditions prevailing at the regions where the moon is in the horizon, so that they give a sort of integrated effect of terrestrial weather.

THE NEW WOLF PERIODIC COMET.—Although this object was of mag. 17 on January 13, Prof. M. Wolf was able to make some interesting observations of its physical structure. "It was a small nebulous object of fan or sector shape, $\frac{1}{2}'$ in width, somewhat less in height, with nuclear condensation in the point of the sector which was towards S.S.E." This structure and the cometary nature of the orbit leave no doubt that it is correctly classed as a comet. The following orbit is by Dr. A. C. D. Crommelin from the photographic positions of December 22, January 13 (Heidelberg), and December 26 (Greenwich):

T	1925, January 23 9624 G.M.T. (new)	
ω	184° 8′ 27″	1924·0
Ω	260 36 36	
i	23 7 9	
ϕ	21 57 47	
μ	472·951″	
Period	7·5022 years.	

An ephemeris is of little use, for very few instruments can reach so faint an object.

There is a very near approach of the orbit at aphelion to that of Jupiter. There is no near approach at the next aphelion (nor has there been any in recent revolutions), but there will be a fairly close approach at the next aphelion but one. Similar elements were obtained by Herr Kahrstedt, who gave the period as 7·43 years.

Research Items.

THE CHRONOLOGY OF CENTRAL AMERICA.—Mr. R. C. E. Long in *Man* for January examines the bearings of the historical evidence upon the correlations of Mayan and Christian chronology put forward by Dr. Morley and Mr. Bowditch respectively. The argument turns upon whether it can be shown that Nahua influence existed in Chichen Itza before its overthrow by Hunnac Ceel, governor of Mayapan, or whether the Nahua buildings in the city—some of the greatest in Yucatan—were erected after that event, as Morley holds. A date deciphered by Morley on a ball-court—a typical Nahua structure—at Uxmal proves the existence of the Nahua in Yucatan before the date to which Bowditch assigned the fall of Chichen Itza. If, then, it can be shown that Nahua influence in Chichen Itza also precedes the fall, that in the light of the Uxmal date would afford strong support to the Bowditch dating, but if it can be shown to be later than that event, it supports the Morley correlation. It seems unlikely that the buildings at Chichen Itza which show Nahua influence would have been erected in a period of great wars, such as this is known to have been, when, as Morley thinks, the city had been handed over to Mexican mercenaries. A conclusive piece of evidence, however, is a passage in the Chilan Balam of Chumayel which states that Hunnac Ceel had himself once been thrown into the Cenote of Sacrifice at Chichen Itza, and that, as he had survived the requisite time, he had been taken out and worshipped. This custom of throwing victims into the Cenote was purely a Nahua practice and was introduced into Chichen Itza only after the establishment of Nahua rule. It follows, therefore, that as the custom must have been observed before the overthrow of Chichen Itza by Hunnac Ceel and not after, the date of the ball-court at Uxmal would fall into line with and support the date suggested by the Bowditch correlation.

MAGIC AND MEDICINE.—An illustrated guide to the collections dealing with medical history in the United States National Museum, Washington, has been compiled by Mr. Charles Whitehead, Assistant Curator of the Division of Medicine, and published as Article 15 of Vol. 65 of the Museum's Proceedings. These collections, which since 1916 have formed part of a larger section of the Department of Art and Industry covering the history of pharmacy, public hygiene and sanitation, are classified under magic medicine, psychic medicine, and pharmacological medicine, the last named including Egyptian, Greek, and Roman medicine, while the first covers the healing art of primitive, savage, and half-civilised man as well as the numerous survivals of primitive medicine among civilised peoples. It is naturally the most fully represented. Among the amulets or charms is a specimen illustrating the voodoo of the negroes of the United States and West Indies, which consists of a chicken feather, some human hair, a drop of blood on a rag, and a pine sliver. This is worn on the neck as a preventive of voodoo against the wearer. A number of "madstones," which, when applied to a dogbite, avert madness, have proved their efficacy in the hands of their former owners. For one, a highly polished seed of *Gymnocladus dioica*, the Kentucky coffee tree, 1000 dollars was asked, and a ball of matted hair, such as is occasionally found in the stomach of domesticated cattle and other ruminants, was said to have been used successfully in two cases. One exhibit is a section of a tree from Norfolk, Va., which had been tapped, human (negro) hair inserted, and the hole plugged and sealed with clay. Four inches of new growth formed over the plug, so that the hair must have been inserted fifty years before it was found. The operation was doubtless performed either to relieve headache, or to cause headache in the original possessor of the hair.

THE BRITISH RACES OF *ARICIA MEDON*, ESPER.—*Aricia medon* occurs in the British Isles in two distinct races, the type *medon* and the variety *artaxerxes*. The type occurs in England and Wales and the variety in Scotland and Ireland, but their areas of distribution overlap in the N.E. of England. Dr. J. W. H. Harrison and Mr. W. Carter (Trans. Nat. Hist. Soc. Northumberland, Durham, and Newcastle-upon-Tyne, N.S., vol. vi. pt. 1) have discussed the origin of these two races. They reject both the possibility of origin from an original mixed population in N.E. England, and an explanation based on orthogenetic mutations. They conclude that the variety originated in a contingent of the type isolated during the glacial period, under the long-continued influence of the refrigerating conditions that obtained at that time, and they cite the experimental results of refrigeration on other species of Lepidoptera in support of their theory. They find, moreover, that in the overlapping areas of their distribution the inheritance follows Mendelian lines.

MERISTEM GROWTH IN WOUNDED POTATOES.—G. A. C. Herklots has a paper in the *New Phytologist* (vol. 23, No. 5, December 1924) in which the cork meristem formed upon cut potato tubers under suitable conditions is used as a means of investigating certain views recently put forward (NATURE, August 16, 1924, p. 258, "Mechanism of Cell Growth") as to the influence of the external hydrion concentration upon the activity of meristematic protoplasm. Experimenting with the cut surface in contact with buffered solutions or jellies, he finds that an alkaline reaction at the cut surface favours rapid suberisation, but delays or (if beyond $P_H 8$) entirely prevents meristem formation, whilst an acid reaction at the cut surface, whilst delaying the process of suberisation, facilitates meristem formation.

A CINCHONA INSECT PEST.—In the report for 1923–24 of the Government cinchona plantations and factory in Bengal, attention is directed to the ravages of Helopeltis. On the plantations both at Mungpoo and Munsong, this pest is on the increase and the attacks have reached and maintained a severity that renders hand-picking ineffectual. The trouble is greater at lower than at higher elevations, and in certain parts of the plantations the growth of the plants is completely suspended for several months of the year. Coppicing as a preventative is beneficial in so far as the affected portions are removed entire, but the disease reappears when the fresh shoots sprout. There seems to be no satisfactory method of dealing with this insect pest. A season that is unfavourable to its development is more beneficial than all the counter measures that have been devised up to the present. In spite of these difficulties and somewhat adverse weather conditions, the plantations did well during the year under review.

ASIATIC SUCCINEIDÆ.—One of the most difficult of the families of the non-marine mollusca to deal with satisfactorily is the Succineidæ. The shells present so few salient characters, whilst far too little is known of their anatomy. All the more credit, therefore, to Mr. H. Srinivasa Rao, of the Zoological Survey of India, for the excellent little monograph he has just furnished of the Asiatic Succineidæ in the Indian Museum (Rec. Indian Mus. xxvi.). The author has

brought together all the facts he was able concerning the anatomy and habits of the members of the family as represented in the Indian Museum, and has principally utilised the jaw and radula for the purposes of distinguishing the various species. The Indian Succineidæ comprise four distinct genera: Succinea itself, which is amphibious, and three terrestrial genera—Indosuccinea, which is new, Lithotis, and Camptonyx. The type of the new genus is *Succinea semiserica* Gould, and the author has further created a few new species and varieties. There are good, clear text figures of the jaws and radula teeth and a very good photo-plate of the shells of the more important species.

RATOONED QUEENSLAND COTTON.—A short note by Mr. Frederick Summers in the Journal of the Textile Institute for December has considerable general interest. When growing wild, the cotton plant is always a perennial, but under cultivation, either because of drought or winter conditions in the resting season, or more usually because of the way in which the pests and diseases of the crop accumulate in the second and succeeding years, it is the rule in Egypt and the West Indies to remove the old stumps after the first year's crop of fruit has been gathered (NATURE, May 31, 1924, p 800) In S America, and also in Africa under native cultivation, the plants are often cut down hard at the end of the growing season, and then allowed to produce fresh shoots in the following season, in other words, treated as from time immemorial bush and woody fruits have been treated in Great Britain In the case of cotton, this process is known as ratooning, and there has been much discussion, on inadequate data, as to whether the ratooned crop, whatever its quantity, is of similar quality with the first year's yield. Fruit growers would naturally tend to assume that quality would be maintained, and one can understand that when new areas come under cultivation for cotton, the pest problem being still little developed, the planters have a natural tendency to follow the practice of ratooning. Queensland growers have done this, although in 1923 for a short period the process was made illegal, as the result of inquiries by the Queensland Ministry of Agriculture as to the esteem in which ratoon cotton is held in Great Britain. This ban has again been removed, and Mr. Summers now reports a careful test of the quality of ratooned fibre as against the normal crop, and it is interesting to see that this examination tells heavily against the ratooned product. This conclusion is of great scientific interest and contrasts strongly with our experience of many perennial plants when brought into cultivation Mr. Summers emphasises the fact that generalisation must not be based upon these Queensland samples alone, but they certainly raise the problem in a very definite form, and both its scientific interest and commercial importance should mean that further opportunities will be taken of comparing authentic samples of ratoon and normal cottons.

THE JAPANESE EARTHQUAKE OF 1923.—The investigation of the disastrous earthquake which devastated Tokyo in September 1923 is still proceeding, but some preliminary reports have already appeared. In the *Geographical Journal* for January, Dr. C. Davison has an article bringing together the information on the subject at present available, in which he discusses, among other aspects of the earthquake, its origin. The epicentral tract of the earthquake was of unusual size and may have covered so much as 2000 square miles, including the whole of Sagami Bay. Its area may even have been 4700 square miles. The cause, at least in part, is to be sought in the movements which produced remarkable changes in the floor of Sagami Bay. These changes were very considerable, and although no fault scarp has been discovered on the floor of the bay, a vast block or series of blocks seem to have subsided. A remarkable feature of this subsidence is that the movements on the floor of the bay have affected very slightly the surrounding coasts. The greatest elevation of the sea-bed was more than a hundred times that on land, and the greatest depression of the sea-bed was more than 1600 times that on land Moreover, the centres of elevation and depression are very close to one another. There is also evidence that the movements on the sea floor were not confined to the time of the earthquake but continued in the same directions for so long as five months, and even now may not be at an end.

MAGNETIC SURVEY WORK IN THE UNITED STATES.—The results of magnetic observations made by the United States Coast and Geodetic Survey in 1923 are published as No. 268 of the survey publications. Five magnetic observatories continued in operation throughout the year, namely, Cheltenham, Md., Sitka, Alaska; Honolulu, Hawaii, Vieques Island, P R; and Tucson, Arizona Their records have furnished the data for reducing to monthly means the values of declination obtained from field observations The magnetic survey of Florida was completed and a survey of North Carolina was made. Declination observations were made at a large number of stations along the southern and south-eastern shores of Alaska in connexion with the triangulation. Tables are given of the year's observations at various stations, and the report concludes with descriptions of the stations sufficiently detailed to enable them to be located even if the marking on the ground should be destroyed

ROTATORY DISPERSION.—The thesis on "The Chemical Significance of Optical Dispersion," on which Dr. Harold Hunter was recently awarded the degree of D Sc (Lond), has been printed and published (London: Battersea Polytechnic, Battersea Park Road, S.W 11; price 7*s* 6*d*) The thesis is a critical account of the recent position of a question which has formed the subject of considerable discussion both pre- and post-War. It presents in a convenient and accessible form the author's own personal contribution to that discussion and his comments on the views of other workers in the same field. There are very few points in the thesis which call for criticism, the principal one being perhaps the statement (p. 89) that "the rotatory dispersion equation of Drude" "suffers from the defect" that "it does not take into account the degradation of the light energy in the phenomenon of absorption," since this "defect" does not exist in Drude's original equation, but only in the simplified equation which alone is quoted by Dr Hunter. On the other hand, a partial transposition into italic type is justified as a tribute of admiration for the neat statement (p. 49) that "One of the consequences of improvements in chemical technique is that *the dynamic isomerism of to-day becomes the static isomerism of to-morrow.*"

THE CONDENSATION AND RE-EVAPORATION OF ACTIVE HYDROGEN.—In an interesting paper (*Zeitschrift für Elektrochemie*, Nr. 21/22, pp. 504-508, 1924) Fritz Paneth discusses the properties of active hydrogen and describes experiments carried out in association with K. Peters. The monatomic form (H_1), produced at low pressures by glowing wires and electric discharges, is readily adsorbed and is condensed on the walls of glass vessels cooled by liquid air, the activity disappearing on re-evaporation. At high pressures another modification is produced,

usually regarded as tri-atomic hydrogen (H_3), in conformity with the observations of J. J. Thomson and Aston on positive rays. H_3 is less strongly adsorbed than H_1 and can pass through glass wool. It is generally recognised by the production of hydrogen sulphide, when it is passed at a very low temperature over powdered sulphur. Wendt and Landauer have described an investigation in which they appear to have been successful in producing not only condensation but also re-evaporation of H_3 without change of form, and, considering the substance analogous to ozone, they suggest for it the name "hyzone." Two new methods are now described in detail for the production and study of this active modification of hydrogen. In the first, hydrogen is passed over a glowing Nernst filament, and in the second, through a heated capillary tube of palladium. The results are believed to prove that active hydrogen so produced may be condensed and re-evaporated without loss of activity, and further, that its constitution must be H_3 and not H_1. Experiments are to be continued with the view of producing the active modification in greater quantities.

THE ISOTOPES OF MERCURY.—An interesting suggestion is made by Dr F. Stumpf in the *Zeitschrift für Physik* of December 12. He directs attention to the facts that Aston has found the atomic weights 204, 202, 200, and 197 for the isotopes of mercury, and that the last number is almost identical with the atomic weight of gold. Although among the radioactive elements there are cases where different elements have the same atomic weight, this is not true for the other, non-radioactive, elements; and the author considers that it is possible that the 197 isotope was really gold and not mercury. Apparently the intensity of the 197 line was not very different from that of the others, so that it can scarcely have been due to gold existing originally as an impurity in the mercury. It is suggested that gold may have been produced from the mercury in the experiment in a similar manner to that in which Miethe claims to have caused this transformation. It might be possible to obtain evidence of this by receiving the positive rays on a plain sheet of glass or of quartz, instead of on a photographic plate; with a long exposure the glass might be coloured red with colloidal gold at the point in question. In Miethe's experiment parts of the discharge bulb were coloured red.

PROTECTIVE COLLOIDS.—A paper on colloidal protection, read by J. Alexander before the American Section of the Society of Chemical Industry last May, is published in *Chemistry and Industry* (Review) for December 19, 1924. The technical use of protective colloids has been known since antiquity. Thus the Chinese used glue in the manufacture of ink to deflocculate the lamp-black, and the ancient Egyptians used gum (probably acacia) for the same purpose. The protective action was recognised by Meyer and Lottermoser (1897). A protector may be defined as a substance which opposes the aggregation of molecules or particles into larger groups; according to Bechold, the protective action is consequent upon the adsorption of a layer of the protector at the interface between the dispersed and the dispersing phase. This layer is exceedingly thin, since it does not diminish the Brownian motion of the particles, and there is no ultramicroscopic evidence of its existence. Brief descriptions and applications are given of plural, auto- and cumulative protection.

PYROPHORIC ALLOYS.—The production and properties of pyrophoric alloys are described by Dr. N. F. Budgen in the *Chemical Trade Journal* for December 26, 1924. The "flint" of the popular type of gas-lighter was introduced by Auer von Welsbach in an interesting manner. The incandescent mantle which Welsbach introduced in 1886 contains 99 per cent. of thoria and 1 per cent. of ceria, and the large demand for thoria which it created led to the working up of the monazite sands found in different parts of the world. These sands contain about 5-10 per cent. thoria and 50-60 per cent. ceria and other rare earths, so that large quantities of rare earths, minus the thoria, accumulated at the mantle works. It was while trying to find a use for this "waste" that Welsbach discovered that alloys of iron and the cerium metals throw off sparks when rubbed with a file. The first step in the production of pyrophoric alloys is the preparation of "misch metal," which is an alloy of 40-50 per cent. cerium, 20-40 per cent. lanthanum, 1 per cent. yttrium, and small amounts of neodymium, samarium, gadolinium, etc. This alloy is then fused and mixed with an appropriate metal (*e.g.* iron, zinc, aluminium) in the molten state under a protective layer of salt or fluorspar. The best pyrophoric alloy is probably "auermetal," made by alloying up to 60 per cent. of iron with misch metal.

PHYSICAL ASPECTS OF CHEMICAL COMBINATION.—A paper on "Chemical Combination as a Dynamic Problem" by Prof. Born, of Gottingen, read at Innsbruck meeting of the German Scientific and Medical Association on September 26, 1924, is printed in *Die Naturwissenschaften* of December 26. The paper deals with the calculation of physical and chemical constants from data as to the electric charges and distances of the components of various aggregates. Thus the "lattice energies" of crystals of the rock-salt type can be calculated and give results which show a very close agreement with the observed values. In other cases, including the molecules of salt-vapours, the ions appear to be deformable, as indicated, for example, by the different refractive power of Cl' in HCl and in NaCl. A table is, however, given of the energy of formation of salt-vapours, in comparison with the lattice energy minus the heat of sublimation. The calculation of the natural free-periods of ions such as CO_3, NO_3, ClO_3, SO_4, etc., which are constant in all compounds of these ions both in solution and in solid crystals, from the charges and distances of the atoms, is also referred to.

THE PROGRESS OF DEVELOPMENT OF A PHOTOGRAPHIC PLATE.—This matter has been investigated by Mr. L. F. Davidson, of the Imperial Dry Plate Company (Journal of the Royal Photographic Society, January 1925), by watching the actual process of development under the microscope, using a high-power objective, and by taking photomicrographs at various stages. The developer was coloured so that its movement was obvious. When the developer reaches a grain, there is a definite time interval before visible action begins, and this "induction period" varies according to the developer used and according to the nature of the grain, but appears to be unaffected by grain size. Development starts at points or "centres" which enlarge and join until the whole grain is blackened. Except in the case of certain slow emulsions, the shape of the grain is changed by its development. If by reason of this change of shape it comes into contact with another grain, this second grain appears to be rendered developable. The developed grain may present an area that is smaller or very much larger than the original silver haloid grain, this alteration in area varying from 0·8 to 104 per cent. in an extended series of experiments. It was sought, though apparently not very successfully, to find some relationship between the increase in size and the character of the plate.

Prize Awards of the Paris Academy of Sciences.

AT the annual public meeting of the Paris Academy of Sciences, held on December 22, M. Guillaume Bigourdan in the chair, the prizes awarded in 1924 were announced as follows:

Mathematics.—The Poncelet prize to Ernest Vessiot, for the whole of his mathematical work, the Francœur prize to the late Ernest Malo, for his researches in algebra and arithmetic.

Mechanics.—The Montyon prize to Eugène Huguenard, Antoine Magnan, and André Planiol, for the important improvements which they have made in hot wire anemometry, the Fourneyron prize to Marcel Crozet-Fourneyron, for his historical work and inventions connected with the hydraulic turbine, the Boileau prize to Georges Routin, for his hydraulic researches, the Henri de Parville prize to Paul Bloch, for his work in ballistics, with especial reference to the projection of missiles from aeroplanes.

Astronomy.—The Lalande prize to Jules Baillaud, for his work in celestial photography, the Janssen medal to George Willis Ritchey, for his work on the construction of mirrors, the La Caille prize to Dominique Saint-Blancat, for his work on the catalogue of stars. The Benjamin Valz prize was not awarded.

Geography.—The Delalande-Guérineau prize to Charles le Maître, for his cartographical work in Algeria, the Gay prize to Émile Delcambre, for his work in topography and meteorology, the Tchihatchef prize between Ernest Benoit (1500 francs), for his work on geodesy in Indo-China, and Laurent Fiquegnon (1500 francs), for geographical work in Indo-China; the Binoux prize between Jacques Bourcart (1000 francs), for his work on the physical geography of Albania, and Édouard de Martonne (1000 francs), for his topographical, geodesic, and cartographical work in French Western Africa.

Navigation.—The prize of 6000 francs between Yves Le Prieur (4000 francs), for inventions connected with naval artillery, and Émile Georges Barrillon (2000 francs), for his study of the gyration of ships, the Plumey prize between Antoine Foillard, for his memoir on marine machines with electric transmission, and Paul Dumanois, for his volume on internal combustion motors.

Physics.—The La Caze prize to Paul Langevin, for the whole of his scientific work; the Hébert prize to Edgar Haudié, for his "Cours d'électricité générale", the Hughes prize to Alexandre Dufour, for his cathodic oscillograph; the Clément Félix prize between Jean Mercier, for his researches on the velocity of propagation of electric waves, and Pierre Fleury, for his researches on the measurement of the temperatures of electric furnaces.

Chemistry.—A Montyon prize (Unhealthy Trades) (2500 francs) to the late André Brochet, for his researches in organic chemistry and electro-chemistry; an honourable mention (1500 francs) to Isidore Lazennec; the Jecker prize to Louis Jacques Simon, for his work in organic chemistry; the La Caze prize to Camille Matignon, for the whole of his chemical work; the Cahours foundation to Suzanne Veil, for her physico-chemical researches on metallic oxides and hydroxides; the Houzeau prize to Pierre Chevenard, for his inventions of apparatus used in metallurgical research.

Mineralogy and Geology.—The Fontannes prize to Frédéric Roman, for his work in palæontology; the Victor Raulin prize to Jules Barthoux, for his memoir on the petrographical and geological study of the Arabian desert.

Botany.—The Desmazières prize to René Vandendries, for his memoirs on sexual determinism and sexuality of the Basidiomycetes, the Montagne prize to Alphonse Labbé, for his volume on the biological cycles of the Dunaliella, the de Coincy prize to François Pellegrin, for his memoir on the flora of Mayambe, from the collections of M. G. Le Testu.

Anatomy and Zoology.—The da Gama Machado prize to Christian Champy, for his researches on the spermatogenesis in *Discoglossus pictus*, the Savigny prize to Clodomir Houard, for his work on galls in Northern Africa; the Jean Thore prize to Adrien Perret-Maisonneuve, for his researches in apiculture.

Medicine and Surgery.—The Montyon prize between Victor Babès (2500 francs) for the whole of his work, Noël Fiessinger (2500 francs), for his volume on the ferments of the leucocytes in physiology, pathology, and general therapeutics, Jules Botreau-Roussel (2500 francs), for his memoir "Ostéites pianiques (Goundou)", honourable mentions (1500 francs) to Jean Baratoux, for his volume on the voice, the scientific study of its formation and emission, its diseases, to Jean Rieux, for his book on clinical hæmatology, and to Henri Glover, for his work entitled "L'auscultation électrique en physiologie et en clinique", the Barbier prize to Georges Mouriquand and Paul Michel, for their experimental work on accessory food substances; the Bréant prize (arrears) between Alfred Boquet and Léopold Nègre (2500 francs), for their work on tuberculosis, and Léon Marchand and Raymond Moussu (2500 francs), for their work on enzootic encephalitis of the horse, the Godard prize to Edmond Papin, for a memoir on endoscopy operations of the urinary passages, the Mège prize to Mme. Angélique G. Panayotatou, for her volume on the hygiene of the ancient Greeks; the Bellion prize between Paul Godin (700 francs), for his works on the evolution of growth, and Louis Bargeron (700 francs), for his researches on the lighting conditions of workshops, the Larrey prize to François Bassères, for his memoir on the medical service of the Third Army in the War.

Physiology.—The Montyon prize to André Charles Guillaume, for his memoir on the normal and pathological morpho-physiology of the small superficial blood vessels, the La Caze prize to Emmanuel Hédon, for his scientific work as a whole, and more especially for his researches on the physiology of the pancreas, the Pourat prize to André Paillot, for his memoir on the bacterial diseases of insects and their utilisation in agriculture, the Martin-Damourette prize to Henri Vignes, for his memoir on normal and pathological obstetrical physiology; the Philipeaux prize to Antoine Léon Garrelon and Daniel Santenoise, for their researches on the oculo-cardiac reflex and vago-sympathetic toxin.

Statistics.—Montyon prizes to Michel Huber (1000 francs), for the whole of his statistical work, and Émile Lambert (1000 francs), for his work in statistics.

History and Philosophy of Science.—The Binoux prize to Mme. Hélène Metzger, for her volume on chemical doctrines in France from the beginning of the seventeenth to the end of the eighteenth century.

Medals.—The Berthelot Medal to André Brochet, Louis Jacques Simon, Camille Matignon, Suzanne Veil, and to Pierre Chevenard.

The Lavoisier Medal to Joseph Achille Le Bel, for his chemical work, as it is now fifty years since the discovery of the asymmetric carbon atom.

General Prizes.—The Grand Prize of Mathematical Sciences to Paul Montel, for his researches on suites of analytical functions; the Bordin prize to Clément Vaney, for his work on the diseases of cattle; the Lallemand prize to Henry Cardot and Henri Laugier,

for the discovery and study of the linguo-maxillary reflex; the Vaillant prize to Claude Guichard, for the whole of his work in higher geometry; the Le Conte prize to André Debierne, for his work in the field of radio-activity, the Houllevigue prize between Franz Lœwinson Lessing (3500) francs), for his work in petrography, and T. Husnot, for his work in botany, the Jean Jacques Berger prize to the Institut prophylactique, the Parkin prize to Ernest Fourneau, for his work in pharmacology, the Saintour prize equally between Paul Camboué, for his researches on silks of Madagascar, and Jean Jacques Kieffer, for his work on parasitic Diptera and Hymenoptera, the Henri de Parville prize to Maurice Vèzes and Georges Dupont, for their book on resins and turpentines and the industries connected with these, the Lonchampt prize between Émile Roubaud (2000 francs), for his work on the hibernation of flies, Ernest Lobstein (1000 francs), for his biochemical researches on the tubercle bacillus, and Paul Fleury (1000 francs), for his researches on laccase, the Henry Wilde prize to Charles Mauram, for the whole of his work and for the organisation of research at the Institut de Physique du Globe, the Caméré prize to M Caquot, for his engineering work in connexion with bridge construction; the Gustave Roux prize to Eugène Séguy, for his work on Diptera, the Thorlet prize to Adolphe Richard.

Special Foundations.—The Lannelongue foundation between Mmes Casco and Ruck

Prix des Grands Écoles —The Laplace prize to Philippe Charles André Coste, the L. E Rivot prize between Philippe Charles André Coste, Lucien Félix Chadenson, Jean Charles Joseph Armanet, Vincent Louis François Pierre Bauzil

Funds for Scientific Research —The Gegner prize to Gustave Dollfus, for his geological work, the Jérome Ponti foundation to the late Hippolyte Coste, for his descriptive and illustrated flora of France, the Hirn foundation to Georges Giraud, for the whole of his work; the Henri Becquerel prize to René Garnier, for his works on differential equations

The Loutreuil Foundation —Thirty-two requests for grants from this fund were received, twenty-four grants were made as follows:

Establishments named by the founder:

National Museum of Natural History: 10,000 francs to P. Pierre Teilhard de Chardin, for palæontological researches in China, Collège de France, 15,000 francs to Henri Piéron, for the purchase of material for researches at the new physiological laboratory;

National Veterinary School at Alfort: 2000 francs to Albert Henry and Charles Leblois to pursue their researches on the etiology, pathogeny, and treatment of the parasitic skin affections of domestic animals, 3000 francs to Gabriel Petit, to pursue his researches on the radio-activation of the organism by intravenous injections of radium; 4000 francs to Gustave Moussu, for his researches on diseases of cattle and pigs; 2000 francs to François Maignon, for his work on insulin and on the mineral elements entering in the constitution of the tissue catalysts of animal and vegetable origin

National Veterinary School of Lyons: 2000 francs to Gabriel Marotel to continue his researches on two parasitic diseases of the horse and dog; 4000 francs to Joseph Basset, to finish his researches on anthrax vaccination; 2000 francs to L. Jung, to pursue his researches on the rôle of the saliva of various domestic animals in its relations with their normal food regime.

National Veterinary School of Toulouse. 2000 francs to Jules Girard and Pierre Pons, for their researches on the modifying factors of growth (temperature, special feeding, castration), 3000 francs to Albert Dalle, to finish his researches on the etiology and serotherapy of epizootic diarrhœa in newly-born calves; 2000 francs to Clément Bressou, to commence researches on the splanchnology of mammals, more particularly Carnivora, by the method of feeding and radio-opaque injections

Grants acceded to establishments admitted for one year by the president

Conservatoire national des arts et métiers 4000 francs to Léon Guillet, for the purchase of a second Le Chatelier metallographic bench.

Independent requests 1500 francs to Jean Bosler, for the *Journal des Observateurs*, 5000 francs to Jean Charcot, for the purchase of material required for the geological study of the sea floor, 3000 francs to Henri Colin, for the purchase of a combustion furnace and accessories, required in connexion with the study of new or little known carbohydrates; 1000 francs to Benjamin Jekhowsky, for assisting his work on new minor planets; 15,000 francs to Jean Mascart, for the publication of observations of variable stars; 3000 francs to the Office central de Chauffe rationnelle, for the study of the composition of a mixture of carbon monoxide and dioxide in equilibrium in the presence of carbon at various temperatures, 1500 francs to Paul Pallary, to pursue his explorations in the Middle Atlas, 5000 francs to Edmond Roy-Prémorant, for the construction of a tachylegometer invented by him; 6000 francs to the Société de Physique industrielle, for the study of the measurement of gas and steam in industry; 6000 francs to the Saint-Joseph University of Beirût, for the publication of the geological map of Syria, constructed by P. Godefroid Zumoffen.

The Bouchard foundation to Gabriel Bidon, to continue his researches on the neuro-physiology and treatment of the deformed; the Henry Le Chatelier foundation to Léon Jacqué, for researches on the fusibility of mixtures of lime, ferrous, and ferric oxides.

Medical Uses of Radium.

THE Medical Research Council has recently published, as No. 90 of its Special Report Series, a summary of reports for 1923 from research centres on the medical uses of radium. The nine clinical centres in Great Britain and Ireland which enjoy the use of radium lent to them by the Medical Research Council have been pursuing these investigations for several years, but this is the first occasion upon which the data have been arranged and used for public circulation. This is particularly welcome now, for results have been obtained which invite the careful consideration of radiologists, physicians, surgeons, and pathologists.

It may be said that the main object of the clinical investigations is to define the proper limitations of the uses of radium in the treatment of malignant disease, and to decide the best methods of treatment for any given type of this disease. Such an aim can be achieved only by very persistent work of a collaborate character continued over some years. The forms of malignant disease are so varied, the differences in reaction of the host are so large, and the factors in dosage are so numerous, that it may well be that more years will elapse before the main object of the Medical Research Council in these investigations is achieved. Yet a perusal of this report convinces the reader that a serious effort is in hand, not only to give these radiological investigations a quantitative

basis, but also to visualise the problem of radium therapy in cancer in all its complexity and yet not be baffled by it.

For some years it has been recognised that rodent ulcer is a disease very amenable to this form of therapy, and this is confirmed in the data before us. Of later years, the value of radium in cancer of the cervix uteri has been maintained, and there is a considerable mass of evidence in this report which substantiates the claim In cancer of the breast, the data show an increasing use of radium combined with surgical operation, but the full value of this combination depends largely upon the nature of the surgical operation and the extent to which it is possible to insert the radium at places of likely extension of the disease. We gather from the report that the results obtained by the use of radium in malignant disease of the mouth, jaw, or throat, continue in most cases to be disappointing This appears to be chiefly due to local anatomical and surgical difficulties rather than to any specific resistance of the tumours themselves.

Non-malignant conditions have also been investigated It is satisfactory to find in the reports from three independent centres, a practical uniformity in the dose of radium employed in the treatment of uterine fibromata and of menorrhagia, and an equal measure of success in the results.

Recognising that progress in therapy is largely dependent upon collateral researches, the Medical Research Council, through its Radiology Committee, has, from the inception of this scheme, supported such researches which have so far been of physical or biological character. Sir Ernest Rutherford reports upon the disintegration of the elements by means of alpha rays

Researches of a biological character are separately detailed as having been carried out by Mr Timbrell Fisher in osteo-arthritis, by Dr J C Mottram on changes in the intestinal tract resulting from radiation, and by Prof S Russ upon the determination of lethal doses of radiation for animal tumours

The publication as a whole is worth serious study, for it is a finger-post along the road of treatment in malignant disease While there are no extravagant claims made for it, it cannot be doubted that radium is a valuable instrument in the treatment of cancer and other diseases, and we look with confidence to the results which these investigations may provide in the near future

Chemistry in India.

THE success which has attended the inauguration of the Indian Science Congress, and the great increase in the amount of new work in chemistry which has occurred in the Indian Empire during the past ten years, has led to the establishment of an Indian Chemical Society, under the presidency of Sir P. C. Rây, with offices at 92 Upper Circular Road, Calcutta, the first number of the Quarterly Journal of the Society has now appeared

Hitherto, chemical papers emanating from India have been published either in the Journals of the Chemical Societies of London or America, or in one or other of the larger continental publications. The disadvantages attaching to this procedure became more and more obvious as the volume of new work increased, because the older Journals are becoming over-burdened, and the need for economy of space necessitated frequent correspondence between authors and editors, entailing grave loss of time in the cases of countries so far distant as India.

Apart, therefore, from the pleasure with which all British chemists will welcome this national effort on the part of India, there will be general agreement among them that the scheme of decentralisation of publications within the British Empire which it implies is the only one which can lead to the rapid and adequate publication of new knowledge and tend ultimately to the real advancement of chemistry. Optimists may dream of the time when there will be one Chemical Society and one Chemical Journal for all the English-speaking races, but until the transportation of matter can be accomplished with a velocity approaching that of light, distance must always act as an obstacle to any such plan, however desirable it may be

The new Journal is a welcome illustration of the development which has taken place in Indian chemistry during recent years There are thirteen papers, and only one of these is published under English names The remaining papers are published by Indians and come from all parts of the Indian Empire Four of them emanate from the College of Science, Calcutta, and this is as it should be, because, for many years past, this Institution has been the backbone of chemical research in India The other communications come from Allahabad, Baroda, Dacca, Cuttack, Benares, and Madras, and constitute a series of which the organising committee and editor have every reason to be proud

The Journal is well printed, and doubtless the structural formulæ, which seem, at times, to have given the printer some trouble, will improve with experience. Older chemists with impaired eyesight will probably quarrel with the colour of the cover, the printing on which is most difficult to read, but these are minor points and do not detract from the value of what is essentially a most creditable and important production. J. F. T.

The Ross Barrier.

IN a paper to the Royal Geographical Society on January 19, Mr. C. S. Wright gave an account of the Ross Barrier and the mechanism of ice movement. There is now little doubt that the barrier is bounded by high land on all sides except the north, although the ranges between Edward Land and the Maud ranges have still to be discovered. The area of this ice sheet may be given as approximately 150,000 square miles. Ample proof is forthcoming that the seaward edge of the barrier is afloat, although it is probably aground at the site of Amundsen's winter quarters east of the Bay of Whales. Observations have proved that the slope of the barrier is very slight and this must be interpreted as evidence that the barrier is afloat even quite close to its southern edge.

The barrier movement is compounded of the result due to the thrust of glaciers from the plateau on the west, south and east, and movement due to the flattening and outward extension of a thick mass of ice under its own weight. Mr. Wright gave evidence in support of the view that these two causes are roughly of equal importance. If no movement were

contributed by glacier thrust, certainly the general level character of the barrier surface would be maintained, provided that the barrier rests on a warm frictionless plane—the sea. If it rested on land, the bottom friction would be high, the temperature low, and the movement slight. On the other hand, the fact that there is little or no local thickening in the region of the outflow of land glaciers to the barrier must indicate an efficient water circulation beneath it In that case, local thickening would involve local depression and increased local melting from below; thus the general surface level would be maintained It is not possible to suppose that floating glacier tongues played no part in the formation of the barrier Such tongues are common in the Antarctic and many of them extend far out to sea.

The barrier had probably a twofold origin Numerous floating ice tongues from the large glaciers at the back of the Ross Sea were no doubt cemented together by sheets of sea-ice formed in situ in the areas between them. The latter process would entail the formation of sea-ice and precipitation of snow thereon at a rate exceeding that at which it melts below

These conditions were certainly possible during the period of maximum glaciation, even if they do not now occur Observations have shown that the rate of increase in thickness of sea-ice does not decrease largely as the thickness increases. This points to the fact that conduction of heat from below is not the sole cause of growth At present there are sheltered positions in which sea-ice can form and maintain itself for more than one year. Mr. Wright, in discussing the mechanism of movement of ice, shows how uncertain and incomplete are our data for the rate of advance of the barrier, its snowfall and contributions to its mass from land glaciers.

University and Educational Intelligence.

ABERDEEN —The University Court has resolved to institute a lectureship in clinical chemistry

Dr. Alexander Bowman has been appointed lecturer on the scientific study of fisheries

CAMBRIDGE —The Statutory Commissioners have been approached by a number of members of the Senate on the question of the retiring age for professors, which was fixed in the recommendations of the Royal Commission at 65 years The Commissioners favour the proposal that the Board of Electors to a professorship may, when a professor reaches the age of sixty-five, invite him to hold office up to an age not exceeding seventy, if it is believed that the interests of the University will best be served thereby. The Board of Electors is to be precluded from making any fresh election of a professor who is already more than 65 years of age, but if a candidate is elected who is over sixty, he may be elected to hold office up to the age of seventy.

Mr W. B. R. King, Magdalene College, has been reappointed assistant to the Woodwardian professor of geology. On the nomination of the Department of Scientific and Industrial Research, Sir Joseph Broodbank is being appointed to the committee of management of the Low Temperature Station for Research in Biochemistry and Biophysics.

The Special Board for Mathematics has reported to the Senate, asking the University to take steps to enable the Tyson Medal to be struck in bronze, instead of in gold as at present, and to be accompanied by a prize in money.

The Board for Engineering Studies has recommended certain changes in the regulations for the Mechanical Sciences Tripos, including the sub-division of certain of the advanced subjects necessary for a First Class. Thus electricity and magnetism is replaced by electric power and electric signalling, and theory of structures and strength of materials by theory of structures (civil) and theory of structures (mechanical). Mechanics of machines also figures for the first time as a separate subject. It is proposed also to establish jointly with the University of Birmingham a diploma in coal-mining engineering, for which the general course of engineering at Cambridge should count as part of the training, this course to be followed by four months' practical experience in a coal mine and a year's course in mining at the University of Birmingham.

EDINBURGH —At the meeting of the University Court on Monday, January 19, the resignation of Sir Harold J. Stiles, Regius professor of clinical surgery in the University, to take effect on March 20, was announced. The Principal expressed the great regret which was felt by the Court, the high appreciation of the eminent services which Sir Harold Stiles had rendered to the University, and the sense of the deep loss which would be sustained upon his retirement, not by the Court alone but by the University as a whole.

The Library of the Geology Department of the University has been indebted for a number of years to the late Sir Archibald Geikie for donations of valuable geological literature. The last consignment has recently been received from his daughters. This Library was gradually built up and strengthened by the Geikie brothers who in turn filled the chair of geology.

LONDON —A course of eight free public lectures on "The Chemistry of the Internal Secretions" will be given by Mr. E. C. Dodds, at the Middlesex Hospital Medical School, at 5 o'clock, on February 3, 5, 10, 12, 17, 19, 26, and March 3; one of four by Dr. J. Duncan Scott, on "The Medullary Centres," at the Physiology Department of St Bartholomew's Hospital Medical College, 6 Giltspur Street, E.C., at 5 o'clock, on February 11, 18, 25, and March 4; and one of four by Sir William I. de Courcy Wheeler, at St. Bartholomew's Hospital Medical College, at 5 o'clock, on February 16, 17, 18, and 19, on "Some Practical Considerations and Experiences in the Conservative Treatment of Fractures of the Pelvis and the Lower Extremity." Two courses of free public lectures at Birkbeck College are announced, namely, four, by Dr. G. G. Coulton, on "Medieval Education" (February 2, 9, 16, and 23), and three, by Prof. E. N. da C. Andrade, on "The Structure of the Atom" (February 5, 12, and 19). The lecture hour in each case will be 5.30, and no tickets will be required.

ST ANDREWS.—The degree of Ph.D. has been conferred on Mr. G. R Ross for a thesis entitled "The Serological and Immunological Characteristics of Tubercle Bacilli after Extraction with Fat Solvents."

APPLICATIONS are invited for two lectureships at University College, Leicester, viz. in physics and in chemistry. The applications must reach the secretary of the college by February 13 at latest.

DR. WALTER MAKOWER has been appointed professor of science at the Royal Military Academy, in succession to Prof. J. Young, retired. Dr. de Mouilpied, who was to have filled this post, resigned without taking up the appointment. Dr. Walter Makower, who was lately chief physicist to the Dunlop Rubber Company, was for many years lecturer in physics at the University of Manchester.

Societies and Academies.

LONDON

Royal Society, January 22.—H. C. H. **Carpenter** and Miss C. F. **Elam**: Experiments on the distortion of single-crystal test-pieces of aluminium. Single crystal test-pieces of aluminium can be extended up to 7 per cent without recrystallising on heating to 600° C. They will recrystallise to form either another single crystal of a different orientation or several crystals, according to the degree of strain. When a large crystal grows from a number of small ones, it has no particular orientation or relation to the direction of mechanical strain. Unless the metal recrystallises, the distortion of the crystal is not removed by heating, and unless the metal recrystallises, the heating does not remove the whole of the hardness acquired through mechanical strain. Hardening by mechanical deformation can take place independently of change of orientation. The proportional increase in hardening is greatest during the early stages of extension, but in the case of single crystals a stage is reached when the increase in hardness is approximately proportional to the amount of plastic deformation.—W. S. **Farren** and G. I. **Taylor**: The heat developed during plastic extension of metals. Hollow bars of certain metals were subjected to plastic stretching. The work done on a measured length in the middle of the specimen was measured, and at the same time the rise in temperature at the centre of the bar was recorded. The heat generated varied from 86·5 per cent. of the heat equivalent of the work done, in the case of annealed steel, to 95 per cent. in the case of single-crystal specimens of aluminium. This ratio remained constant for one material during the whole range of the extension, which in the case of aluminium amounted to more than 50 per cent. of the initial length.—J. V. **Howard** and S. L. **Smith**: Recent developments in tensile testing.—R. L. **Smith-Rose** and R. H. **Barfield**: On the determination of the directions of the forces in wireless waves at the earth's surface. The propagation of wireless waves over the earth's surface implies the reception of two or more distinct waves at an appreciable distance from the transmitting station. One of these is assumed to arrive at the earth's surface after reflection or refraction from the upper portions of the atmosphere, and an attempt is made to detect it by measuring the inclination of the wave-front of the arriving wave. Such a down-coming wave would give rise to a reflected wave which, at the earth's surface, will interfere with the incident wave in such a way as to tend to eliminate the horizontal component of the electric force and the vertical component of the magnetic force. The conductivity of the earth at wireless frequencies was determined experimentally by measuring the "forward tilt" of the waves arriving from neighbouring transmitters for a number of sites in South England. A moderately consistent value of about 10^8 (e.s.u.) was obtained, and calculations from this value show that the directions of the resultant forces at the surface will always be sensibly the same as those of a horizontally propagated wave.—D'Arcy **Thompson**: On the thirteen semi-regular solids of Archimedes, and on their development by the transformation of certain plane configurations. The thirteen isogonal non-isohedral solids attributed to Archimedes stand in close relation to the ten regular plane repeating patterns or "nets" first described by Kepler, which consist of regular and identical sets of congruent polygons. If, in the table of indices giving the number of triangles, squares, etc., found at each junction (or node), the *order* of an index be successively reduced, we pass accordingly from the plane polygonal assemblage to some one, and then to another, and so on, of the indices which characterise the several polyhedra. This transformation may be performed mechanically, by constructing a hinged net, removing (*i.e.* replacing by fenestræ) the polygons of a certain order, and allowing those which remain to slide over and so overlap one another.—F. G. **Mann** and Sir William **Pope**: 1 2 3-Triaminopropane and its complex metallic compounds.—D. L. **Chapman**, J. E. **Ramsbottom**, and C. G. **Trotman**: The union of hydrogen and oxygen in presence of silver and gold. The catalytic activity of silver is considerably reduced by heating to dull redness in oxygen, independently of the pressure of the oxygen in which it has been heated, provided that this pressure exceeds 0·005 mm. of mercury. As the pressure of the oxygen is diminished further, the activity of the treated metal falls rapidly, reaching a maximum when the oxygen pressure is 0·0013 mm. After silver has been heated to dull redness in oxygen at a pressure higher than 0·005 mm., it would seem to be covered with a thin film of silver oxide, which is a less powerful catalyst than the metal itself. Gold furnished similar but less pronounced results. In the presence of the film of silver which was formed on the surface of the glass during the experiments, hydrogen and oxygen will combine at the temperature of the laboratory.—U. R. **Evans**: The colours due to thin films on metals. Mallock has objected to the interference-theory of the colours on the grounds that he had failed to alter the colours of tempered iron by polishing the metal. It has now been shown that the colours can be changed when the thickness of the film is uniformly reduced by cathodic treatment in dilute hydrochloric acid. Raman has proposed that the colours are due to a granular structure; but the colours on molten lead can be obtained as easily when the oxide-film is molten as when it is solid, and thus the "granular theory" fails. The oxide-films have been lifted off molten lead, and examined, supported on glass, the colours by transmitted light are complementary to those by reflected light, as is to be expected on the interference view.—A. **Campbell**: On the determination of resistance in terms of mutual inductance. A new method of balancing mutual inductance against resistance is described, in which one of the conditions of balance is independent of frequency and can be set once for all, while the second condition gives a very simple relation between the frequency, two resistances and two mutual inductances.—S. **Butterworth**: On the alternating-current resistance of solenoidal coils. The general theory of eddy-current losses in cylindrical conductors is employed to establish formulæ for computing the alternating-current resistance of single-layer solenoidal coils. Two formulæ are obtained which are shown to be in reasonable agreement with observation, except when the frequency is extremely high. The formulæ should be applicable so long as the current may be regarded as having uniform distribution throughout the coil.—A. J. **Allmand** and V. S. **Puri**: The effect of superposed alternating current on the polarisable primary cell zinc—sulphuric acid—carbon. Part I.: Low-frequency current. Ten years ago Brown showed that, if an alternating current of either 100 or 12,000 periods and of suitable intensity were passed through the above primary cell, the polarisation of the latter was reduced and its current output increased. The experiments were repeated and extended, using alternating-current frequencies of 20 to 400 cycles per second, the potentials of the two electrodes being measured whilst the currents were running. The

results showed conclusively that, with such frequencies, the carbon electrode is chiefly responsible for the decreased polarisation and increased cell current The lower the frequency, the greater the effect. At the same time there were certain indications that, with higher frequencies, an effect would be produced at the zinc electrode, as observed by Brown.—R W Lunt The interaction of carbon dioxide and hydrogen in the corona due to alfernating currents of high frequency Alternating electric fields of frequency $1\cdot5\times10^7$ have been used An equimolecular mixture interacts, giving a water-gas equilibrium, which is also attained by exposing mixtures of carbon monoxide and water vapour to the discharge In no case has it been possible to detect the formation of formic acid or formaldehyde T. **Royds** The apparent tripling of certain lines in arc spectra As many spectra as possible were searched through the visible region for instances of lines becoming complex when the amount of material in the arc was increased Only seven cases were found, all of which apparently become triple with a sufficient quantity of material The Tl line 5350 passes through five successive phases, namely, broad simple reversal, triplet, doublet, a second triplet form, and a final doublet, as the amount of material in the arc burns out This line is essentially a doublet, and all the different phases can be explained as different stages in the self-reversal of the two lines of the doublet A similar explanation was adopted for the six remaining instances of apparent tripling, as all except two were found to assume a doublet form as the final phase —E. **Newbery**: Overvoltage and transfer resistance

Physical Society, December 12 —A C. **Egerton**: Numerical values of chemical constants and frequencies of the elements. The experimental evidence for the general chemical constant C_0 possessing the theoretical value ($-1\cdot589$) is collected. A linear relation between logarithm of mass and characteristic temperature is indicated —J H **Powell**: The sensibility of circular diaphragms for the reception of sounds in water The diaphragms were mounted with one face immersed in water and to the other was attached a microphonic or electro-magnetic detector They were all designed to have a frequency of 850~ under these conditions The response of the diaphragms to sounds of a single definite frequency was measured, and resonance curves were obtained from which the magnitude of the damping due to the detector was determined The corrected values for the resonance amplitude and for the persistence of vibration were consistent with those determined mathematically by Prof H. Lamb for diaphragms under ideal conditions The investigation was extended successfully to cover complex sounds or "noises" of no definite pitch —A. **Campbell**. A direct-reading frequency meter of long range A direct-reading frequency meter for audio frequencies is described It is a null instrument, reading by single adjustment, the working system embodying a new method of balancing mutual inductance by resistance The standard type has five ranges, covering from 180 to 4000~ per second, with accuracy of the order of 1 in 1000, and negligible temperature coefficient except at the lowest frequencies

Linnean Society, January 8 —E. S. **Goodrich**: On the cranial roofing-bones in the Dipnoi. A general fundamental plan of the roofing-bones of the skull can be made out, to which conform the primitive Teleostomi and Tetrapoda The earliest fossil dipnoan, Dipterus, appears to possess the usual paired frontals and parietals (still more distinct in Scaumenacia); but Messrs. Watson and Gill identify these as nasals and frontals, and believe the parietals to be represented by the median posterior occipital plate. The bones in early Dipnoi conform to the general plan; but in the course of specialisation the paired frontals and parietals tend to become reduced in size, separated in the middle line, and more and more superseded by a series of median elements, of which the median occipital is the largest and most constant —C. C. **Lacaita**. (1) A note on *Colchicum montanum* Linn The name *Colchicum montanum* must be abandoned altogether. It has generally been used for the Italian *C Bertolonii*, but *C montanum* of Linn Sp Pl. is a mixture of *Merendera Bulbocodium* with *Colchicum alpinuum*, while the specimen in herb. Linn is really *C Bulbocodium* from the eastern Mediterranean. It was not sent to Linnæus by Loefling, for it does not grow in Spain, and the sheet is marked on the back "Habitat in Morea" The spring-flowering *C Bulbocodium*, with broader leaves and more nerves in the sepals, is a distinct species from *C. Bertolonii* (2) Some critical species of Marrubium The Linnean diagnoses were written for Hort Cliff, and only repeated in Sp Pl Therefore H Cliff. specimens and not those of herb Linn are decisive, except in the case of *M hispanicum* The Adriatic plant usually called *M candidissimum* is not that of Linnæus, and must bear the name of *M incanum* Desr. True *M candidissimum* Linn is a species from Asia Minor J C **Waller** On types of electric response in plants

DUBLIN

Royal Irish Academy, January 12 —H **Ryan** and J **Lennon**: The condensation of aldehydes with methylethylketone: γ-benzylidene-methylethylketone condenses with benzaldehyde to yield isomethyldiphenylcyclopentenone, with anisaldehyde to yield 1-methyl-4-anisyl-5-phenyl-cyclo-penten(3)-one(2) and with piperonal to form 1-methyl-4-piperonyl-5-phenyl-cyclo-penten(3)-one(2) When isomethyldiphenylcyclopentenone is warmed with dilute alcoholic hydrochloric acid, it changes into methyldiphenylcyclopentenone This compound condensed with benzaldehyde to yield benzylidene-methyldiphenylcyclopentenone, which is identical with the tri-condensation product of benzaldehyde and methylethylketone obtained by Ryan and Devine. Anisaldehyde condensed with methylanisylphenylcyclopentenone to yield anisylidene-methylanisylphenylcyclopentenone, and the isomeric compound obtained by Ryan and Devine by the action of anisaldehyde on α-benzylidene-methylethylketone is anisylidene-methylphenylanisylcyclopentenone.

CALCUTTA

Asiatic Society of Bengal, January 7 —Johan van **Manen**: A collection of Tibetan proverbs. More than 200 sayings have now been gathered —Sunder Lal **Hora**: On the habits of a succineid mollusc from the Western Ghats. In August 1924 a new species of Succinea was discovered hibernating on the bark of mango trees at Lonavla. Several members of the family Succineidæ are known to tide over periods of draught by æstivating, but none have so far been recorded in a comatose condition during the rainy season Other members of this family have been found on rocks, but this is the first occasion when a succineid mollusc has been found hibernating on barks of trees.

SYDNEY.

Linnean Society of New South Wales, November 26. —H. M. **Hale**: Two new Hemiptera from New South Wales. Description of a new genus, from Berowra

Creek and Epping, belonging to the Notonectinæ, and a new species of Salda from Wentworth Falls.—W. A. **Haswell**: Critical notes on the Temnocephaloidea. A description is given of the female part of the reproductive apparatus in various species of Temnocephala from Australia, New Zealand, and South America. The relations of the vesicles variously known as receptacula seminis, receptacula vitelli, and vesiculæ resorbientes are described and their functions and homologies discussed.—P. **Brough**, J. **McLuckie**, and A. H. K. **Petrie**: An ecological study of the flora of Mt. Wilson. Pt. I: The vegetation of the basalt. The origin and distribution in Eastern Australia of the Malayan floristic elements are discussed, and an account is given of the structure, composition, inter-relationships, and distribution of the plant communities occupying the basalt caps at Mt. Wilson, the flora of which is largely composed of Malayan elements. A detailed study is made of the overlapping of the Malayan flora of the basalt, and the endemic flora of the adjacent sandstone.

WASHINGTON, D.C.

National Academy of Sciences (Proc., Vol. 10, No. 11, November).—H. **Fricke** and O. **Glasser**. The secondary electrons produced by hard X-rays in light elements. The ionisation current was measured in ionisation chambers (0·5-9 c.c. in volume) constructed entirely of the material under examination, which are small in comparison with the path of the photo-electrons in the chamber. In these circumstances, the current can be represented, according to Compton's theory of scattering of X-rays, as the sum of two quantities, one of which is independent of the effective atomic number of the scattering substance. The ratio of these quantities is determined and agrees with that calculated, using Compton's theory, from other data, for two nearly homogeneous radiations.—C. **Barus**: The diffusion of hydrogen into air, measured by the interferometer U-gauge. Essentially, the method is to measure the pressure at the closed top end of a vertical tube while hydrogen diffuses from the open bottom end. Using various tubes of different length and diameter, the diffusion constant is always considerably higher than the generally accepted value.—W. N. **Birchby**: White light interference fringes with a thick glass plate in one path. A glass plate is inserted in one of the paths of a Michelson interferometer. The fringes are alternately red and green, while the central fringes are indeterminate. For the central region the effect is due to interference in one narrow range of the spectrum superimposed on uniform illumination from the rest of the spectrum.—J. **Kendall** and J. F. **White**: The separation of isotopes by the ionic migration method. If isotopic ions have significant different mobilities, it should be possible to effect separation by electrolysis (NATURE, June 2, 1923, p. 763). Preliminary short runs were made in which it was found possible to effect separation of iodide and thiocyanate ions (16 per cent. mobility difference), barium and calcium ions (8 per cent. difference), barium and strontium ions (5 per cent. difference), and iodide and chloride (about 1 per cent.). A 5 cm. sodium chloride section (0·1 N) between sodium hydroxide and acetate was moved 1000-2000 cm. with inconclusive results. The tubes used, 1·5 in. wide, are not big enough to give segments suitable for ordinary analysis.—W. J. **Crozier**: On the possibility of identifying chemical processes in living matter. Chemical transformations proceed according to Arrhenius's equation, that the velocity of monomolecular change is proportional to the exponential of $-E/RT$, where R is the gas constant, T the absolute temperature, and E is the amount of heat required to convert 1 gm. molecule of the reactant from an inactive to a reactive form. E is thus characteristic of the reactant and, in simple chemical processes, of the catalyst. The velocities of many biological processes are influenced by temperature in a manner similar to ordinary chemical reactions, and the critical increments, or *temperature characteristics*, of the former fall into definite groups. Physiological transformations of a similar type give identical values for this constant suggesting the presence of similar catalytic agents (*not* enzymes). This points to the possibility of the identification of chemical transformations in undisturbed living matter.—R. L. **Moore**: Concerning sets of segments which cover a point set in the Vitali sense.—A. E. **Kennelly**: Time constants for engineering purposes in simple exponential transient phenomena.

Official Publications Received.

Publications of the Astronomical Institute of the University of Amsterdam. No. 1. Researches on the Structure of the Universe. 1. The Local Starsystem deduced from the Durchmusterung Catalogues. By A. Pannekoek. Pp. 5+122+6 charts. (Amsterdam: Stadsdrukkerij.)

Europe as an Emigrant-exporting Continent and the United States as an Immigrant-receiving Nation. Hearings before the Committee on Immigration and Naturalization, House of Representatives, Sixty-eighth Congress, First Session, March 8, 1924. Serial 5-A. Statement of Dr. Harry H. Laughlin. With Appendices printed by Authorization of the Committee, including (1) Text of Immigration Act of 1924 and the Proclamation of the President in connection therewith, (2) Report of the Rome Conference on Emigration and Immigration, and (3) Other important Studies and Official Reports on Migration Problems down to November 19, 1924. Pp. v+1281-1487. (Washington: Government Printing Office.)

Department of the Interior. Bureau of Education. Bulletin, 1924, No. 7. Statistics of Public High Schools, 1921-1922. Prepared under the Direction of Frank M. Phillips. Pp. 69. 10 cents. Bulletin, 1924, No. 11: Manual Arts in the Junior High School. By William E. Roberts. Pp. iv+89. 15 cents. Bulletin, 1924, No. 20. Statistics of Universities, Colleges and Professional Schools, 1921-22. Prepared under the Direction of Frank M. Phillips. Pp. 161. 20 cents. (Washington: Government Printing Office.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 278. Earth Movements in California. By William Bowie. (Special Publication No. 106.) Pp. 22. (Washington: Government Printing Office.) 5 cents.

Ministry of Agriculture, Egypt. Technical and Scientific Service. Bulletin No. 48 (Botanical Section). The Effects of Heat Treatment of Cotton Seed and its Germination and on the subsequent Growth and Development of the Plants. By James Templeton. Pp. 9+3 plates. (Cairo: Government Publications Office.) 5 P.T.

Air Ministry. Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report and Results of Meteorological Observations, for the Year 1923. By Joseph Baxendell. Pp. 28. (Southport: Fernley Observatory, London: Meteorological Office.)

Havsforskningsinstitutets Skrift. No. 17. Wasserstandsregistrierungen in Helsingfors 1904-1920. Von Henrik Renquist. Pp. 75+3 plates. 15 Fmk. No. 19. Dagliga vattenståndsuppgifter 1921. Referat. Tagliche Wasserstandsangaben 1921. Av Henrik Renquist. Pp. 30. 3 Fmk. No. 20: Regelbundna iakttagelser av havets temperatur och salthalt under år 1921. Referat. Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1921. Av Gunnar Granquist. Pp. 54. 6 Fmk. No. 22. Isarna vintern 1920-21. Referat. Das Meereis im Winter 1920-21. Av Gunnar Granquist. Pp. 79+11 plates. 30 Fmk. No. 24: Ström- och vindobservationer vid fyrskeppen år 1922. Referat: Strom- und Windbeobachtungen an den Leuchtschiffen im Jahre 1922. Av Gunnar Granquist. Pp. 40. 4 Fmk. No. 25. Havsforskningsinstitutets verksamhet under år 1922. Av Rolf Witting. Pp. 25. 3 Fmk. No. 26: Regelbundna iakttagelser av havets temperatur och salthalt under år 1922. Referat. Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1922. Av Gunnar Granquist. Pp. 53. 6 Fmk. No. 27: Talassologiska varexpeditionen 1923. Referat. Die thalassologische Terminfahrt im Jahre 1923. Av R'sto Jurwa. Pp. 28+1 plate. 4 Fmk. No. 29: Dagliga vattenståndsuppgifter 1922. Referat. Tägliche Wasserstandsangaben 1922. Av Henrik Renquist. Pp. 44. 7 Fmk. No. 31. Havsforskningsinstitutet verksamhet under år 1923. Av Rolf Witting. Pp. 25. 4 Fmk. (Helsingfors.)

A Short Account of the Growth of the University of Leeds. Pp. 31. (Leeds.)

Leeds University. General Prospectus. Jubilee edition. Pp. 47+6 plates. (Leeds.)

Diary of Societies.

MONDAY, FEBRUARY 2.

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30.

ROYAL INSTITUTION OF GREAT BRITAIN (General Meeting), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Z. Cope: Extravasation of Bile.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—A. S. Buckle: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Plymouth), at 6.—H. Marryat: Electric Passenger Lifts.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—G. Rogers: Automatic and Semi-Automatic Mercury Vapour Rectifier Substations.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—G. B. Walker: The Design and Construction of a Piano Player.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.), at 8.—Prof. G. H. Langley: Values and Temporal Experience.

ROYAL SOCIETY OF ARTS, at 8.—V. E. Pullen: Radiological Research—a History (III.) (Cantor Lectures).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—E. J. Lush: Kinetics of Hydrogenation.—C. O. Condrup and E. W. Smith: Tar Distillation by means of the T.I.C. (Lead Bath) Process.

INSTITUTE OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club), at 8.—W. G. Martin: The Calender in the Rubber Industry.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—President's Address and Presentation of Prizes.

TUESDAY, FEBRUARY 3

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. H. R. Hall: The Connexion and Relations of the Prehistoric Greek and Ancient Egyptian Civilisations (II.).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, at 5.30.—Prof. W. L. Bragg: (*a*) Model illustrating the Formation of Crystals; (*b*) Exhibit of Diffraction Gratings constructed to illustrate the Effect of Crystals on X Rays.—R. W. James: The Structure of Barium Sulphate.—Dr. E. C. S. Dickson: The Flettner Rotor Sail.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. H. I. Waterman and J. N. J. Perquin: Decomposition of Paraffin Wax at 450° C. in Presence and in Absence of Hydrogen under High Pressure.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of November and December 1924.—G. C. Robson: Exhibition of a Giant Squid (*Stenoteuthis caroli*) recently stranded on the Yorkshire Coast.—M. S. Mackinlay: The Language of the Emotions.—Universal Methods of Expression.—Dr. N. S. Lucas: Ill-health in Captive Wild Animals and its Causes.—Prof. O. Fuhrmann and Dr. Jean G. Baer: Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunnington, F.Z.S., 1904–1905.—Report on the Cestoda.—Doris R. Crofts: The Comparative Morphology of the Cecal Gland (Rectal Gland) of Selachian Fishes.—S. Hirst: Descriptions of New Acari, mainly parasitic on Rodents.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—W. B. Lewis and G. S. Irving: The Treatment of Boiler Feed Water.

INSTITUTION OF ELECTRICAL ENGINEERS (North Western Centre) (at Engineers' Club, Manchester), at 7.—A. B. Mallinson and others: Discussion on Justifiable Small Power Plants.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—Discussion on Metal Melting.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section) (at Broadgate Café, Coventry), at 7.15.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—Dr. T. Slater Price: The Action of Light on the Photographic Plate.—J. I. Graham and F. Lawrence: The Use of Iodine Pentoxide in the Estimation of Carbon Monoxide.

INSTITUTE OF METALS (North East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.

RÖNTGEN SOCIETY (at British Institute of Radiology, 32 Welbeck Street, W.), at 8.15.—Major C. E. S. Phillips: Constant Voltage High Tension Generators.—C. H. Holbeach: (*a*) Some Further Aspects of the Theory and Operation of Potter Bucky Diaphragms; (*b*) Demonstration of the New C.D.X. Dental X-Ray Equipment.

WEDNESDAY, FEBRUARY 4

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. P. W. White: The Pathology of Hydronephrosis.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. A. Heard: The Petrology of the District between Nevm and Clynnog-fawr (Carnarvonshire).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—L. B. Turner and F. P. Best: The *Optimum Damping* in the Auditive Reception of Wireless Telegraph Signals.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—Presidential Address.—(Ordinary Meeting).—Dr. D. Hooper: Cinchonine as a Tannin Precipitant with Special Reference to the Analysis of Cutch and Gambier.—C. Ainsworth Mitchell: The Examination of Charred Documents.—H. R. Ambler: The Absorption of Carbon Monoxide in Gas Analysis.

ROYAL SOCIETY OF ARTS, at 8.—Sir Ernest Rutherford: The Stability of Atoms (Trueman Wood Lecture).

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF MEDICINE (Surgery, Medicine, Anæsthetics, Pathology, Obstetrics and Gynæcology Sections), at 8.—Sir Charles Gordon-Watson, E. C. Lindsay, and others. Special Discussion on The Prevention and Treatment of Post-Operative Pulmonary Affections.

THURSDAY, FEBRUARY 5.

ROYAL SOCIETY, at 4.30.—H. M. Carleton. Growth, Phagocytosis and other Phenomena in Tissue Cultures of Fœtal and Adult Lung.—F. W. Fox and J. A. Gardner: The Origin and Destiny of Cholesterol in the Animal Organism. Part XIV. The Cholesterol Metabolism in Normal Breast-fed Infants.—H. H. Thomas: The Caytoniales. A new Group of Angiospermous Plants from the Jurassic Rocks of Yorkshire.—Dr. Winifred Brenchley and H. G. Thornton: The Relation between the Development, Structure, and Functioning of the Nodules on *Vicia Faba* as influenced by the Presence or Absence of Boron in the Nutrient Medium.—*To be read in title only*.—A. S. Rau, F. W. R. Brambell, and Prof. J. B. Gatenby. Observations on the Golgi Bodies in the Living Cell.—V. Nath: Cell Inclusions in the Oogenesis of Scorpions.—L. J. Harris: The Combination of Proteins, Amino-Acids, etc. with Acids and Alkalis and their Combining Weights, as determined by Physico-Chemical Measurements.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. G. P. Bidder: Growth and Death. a Discussion.—Dr. J. Burtt-Davy: The Geographical Distribution of the Arborescent Vegetation of Subtropical South Africa.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Properties and Structure of Quartz (II.).

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Air Commodore C. R. Samson: The Operation of Flying Boats in the Mediterranean.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Mrs. V. Plincke: The Waldorf School, Stuttgart.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. J. H. Jeans: Electrical Forces and Quanta (Kelvin Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—P. G. J. Guetsebock: Tin.

CHEMICAL SOCIETY, at 8.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—Prof. H. E. Armstrong: Colour Problems.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Meeting).—J. Biggam: Methods of Determining the Properties of Steam.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Meeting).

FRIDAY, FEBRUARY 6

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—J. T. Marten: The Indian Census.

ROYAL DUBLIN SOCIETY, at 4.30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. H. Todd: Syphilitic Arthritis.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—J. B. Dahlerus: Anti-Friction Bearing Applications for Heavy Duty.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—Dr. T. Callan: The Detection and Determination of Alpha-Naphthol in Beta-Naphthol.—W. J. S. Naunton: Some Organic Rubber Vulcanising Accelerators.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. G. Herbert: The Measurement of Hardness and Allied Properties of Metals.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—H. Smith: Constructional Work.

PHILOLOGICAL SOCIETY (at University College), at 8.—N. W. Thomas: The Sudanic Languages.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. R. W. Chambers: The Earliest Recorded Kings of the English.

SATURDAY, FEBRUARY 7

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—Dr. J. R. Leeson: The Evolution of Man.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. H. Fellowes: The Elizabethan Ayre.

PUBLIC LECTURES.

SATURDAY, JANUARY 31.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Empire *of* Egypt.

MONDAY, FEBRUARY 2

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: International Labour Organisation.

BIRKBECK COLLEGE, at 5.30.—Dr. G. G. Coulton: Medieval Education (I.). The Monastic School.

TUESDAY, FEBRUARY 3.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 5.—E. C. Dodds: Chemistry of the Internal Secretions. (Succeeding Lectures on February 5, 10, 12, 17, 19, 26, and March 3.)

UNIVERSITY COLLEGE, at 5.30.—W. J. Perry: The Beginnings of Civilisation.—W. H. Baynes: Some Aspects of Byzantine Civilisation (I.). Constantinople. (Succeeding Lectures on February 10, 17, 24.)

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Religious Ideas of Plato.

GRESHAM COLLEGE, at 6.—A. E. Hinks: Our Place in the Universe. (Succeeding Lectures on February 4, 5, 6.)

UNIVERSITY OF LEEDS, at 8.—Dr. W. H. Pearsall: Woodlands and Moorlands in Yorkshire.

WEDNESDAY, FEBRUARY 4

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—H. P. Shapland: The Principles of Design as applied to Furniture.

KING'S COLLEGE, at 5.30.—Prof. A. Mawer: The Viking Age, A.D. 800-1000.

UNIVERSITY COLLEGE, at 5.30.—R. E. Flower: The Use of Libraries (II.). Collections and Manuscripts.

THURSDAY, FEBRUARY 5.

BIRKBECK COLLEGE, at 5.30.—Prof. E. N. da C. Andrade: The Structure of the Atom (I.). (Succeeding Lectures on February 12, 19.)

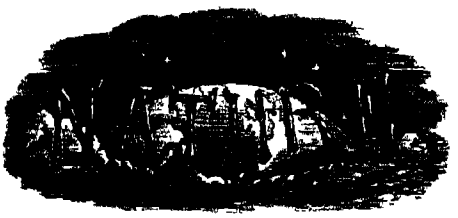
KING'S COLLEGE, at 5.30.—Lt.-Commdr. A. S. E. Sutton: The Civilisation of China: General View.

FRIDAY, FEBRUARY 6.

UNIVERSITY OF LEEDS AND LEEDS PHILOSOPHICAL AND LITERARY SOCIETY (at Philosophical Hall, Leeds), at 8.—Prof. J. Garstang: The Archæology of Palestine.

SATURDAY, FEBRUARY 7.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. P. G. Denman: The Development of Modern Radio Communication.



SATURDAY, FEBRUARY 7, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2884, VOL. 115]

The Future of the British Patent Office.

THE British patent system is a matter which concerns all workers in applied science, for it represents an attempt—faulty and incomplete, but still an attempt—to secure for such workers the credit for their achievements, together with a share of the material advantages arising from these. Hence any event which seriously affects the future of the patent system is one to which the scientific world should give careful consideration, and such an event is just beginning to appear on the horizon. Lest it should take shape before its implications have been seriously canvassed, it may be well to direct attention to some of its aspects. There is a rule which requires Government servants to submit to superannuation at an age when many men are still capable of their best work, and since the rule appears to be inexorably applied, the retirement of the present Comptroller of the Patent Office and the appointment of his successor must be regarded as inevitable in the not very distant future. It is perhaps a little early to discuss this question, but not too early, for when the first official intimation of such a change is given, the selection of the successor may be actually, if not formally, a *fait accompli*.

That a scientific office should have a scientific man at its head is a principle which seems obvious but needs to be constantly reasserted, because the administrative officials who influence such appointments are not always sympathetic towards the claims of science. In fact, a lack of sympathy in that direction is sometimes manifested to a degree which exposes it to strong criticism, as in the proceedings of committees A, B, and C of the National Whitley Council, and in the general tendency to regard the man of science as a mere adviser who is himself incapable of administrative work. Such an attitude is the more unjustifiable from the fact that a scientific training is necessarily always *additional* to some degree of education in the humanities, whereas a literary scholar may be quite ignorant of science; so that the former type of upbringing is the more likely to produce the breadth of outlook which is necessary in handling men and affairs.

Taking the British Patent Office as an example, let us examine the qualifications which are necessary in the man who is to direct its labours. The duties of the Comptroller fall under three heads as follows:

(1) He is the senior Hearing Officer for disputes as to patents, trade marks, and designs. He has to adjudicate in "oppositions" brought by interested parties against the grant of particular patents, as well as in cases where examiner and applicant fail to agree in regard to the official requirements put forward by

the former. Thus the Comptroller is a court of first instance for certain classes of patent litigation; and although he delegates this duty in a proportion of cases to subordinate Hearing Officers drawn from the examining staff, in the remaining cases he acts personally. For the adequate discharge of this function, the importance of which is obvious, the Comptroller should have legal knowledge, experience of patent practice, and such a wide training in scientific matters as to be able readily to appreciate, in the structure and functioning of electrical, mechanical, and chemical systems, those details and subtleties around which patent litigation so frequently turns. Should he lack the latter qualification, the new Comptroller would in many instances be thrown on the mercy of his advisers from the examining staff, and so would relinquish both his dignity and, in the case of disagreement between examiner and applicant, his judicial neutrality.

(2) He will command the staff of the Patent Office, in addition to those of the Trade Marks and Designs Branches The essential work of the Patent Office is carried on by the examining staff, comprising (according to the last Annual Report) more than 250 men having the necessary scientific qualifications, while the routine incidental to their labours necessitates a supplementary staff comprising roughly an equal number of clerical workers. It would be unreasonable to subordinate the examining staff, in the years that lie ahead, to the control of a man who is not qualified, by a scientific training similar to theirs, to understand the outlook and the mentality with which such training is associated. It must be remembered that fundamental changes in the relative importance of the scientific and clerical sections of the staff have followed the changes introduced into the patent system by the Act of 1907.

(3) The new Comptroller will be called upon to advise the government of the day with regard to the improvement and extension of the patent system, which has certain unsatisfactory features, the chief being its incompleteness It is incomplete because the official search is arbitrarily limited to British specifications, because it is imperfectly co-ordinated with other patent systems throughout the British Empire, and because adequate use is not made, for the benefit of national and industrial technology, of the special knowledge acquired by the examining staff (though the latter criticism does not apply to the War period, when many of the staff were drafted to the Ministry of Munitions). In the reconstruction of the Patent Acts the new Comptroller will play a pivotal part, and it is desirable, therefore, that he should have first-hand knowledge of the way in which the present system has worked in practice. Equally must he be a man of broad views and open mind, gifted with that sense of proportion and that *flair* for actualities which characterise the thinking of the quantitative and experimental sciences.

Where, it may be asked, is it possible to find a candidate possessing the necessary legal knowledge, scientific training, experience of patent practice, and largeness of outlook? Three classes of men immediately suggest themselves: (1) The patent bar, (2) the patent agents, and (3) the examining staff of the Patent Office itself. There are difficulties to be encountered in each case. As regards the third group, it is not the general practice of the Treasury to put at the head of a department a man promoted from within it, and we do not know in what circumstances exceptions to this rule are considered feasible. If the Comptrollership should be filled from within the Board of Trade, technical and not purely administrative attainments should decide the appointment. As regards the other two classes, the difficulty is that successful patent barristers and successful patent agents are able to make incomes many times greater than the salary attached to the Comptrollership The dignity of the office might *perhaps* combine with the opportunity of public service which it offers to attract a man of the necessary calibre, but there is a fairer and wiser way to meet the difficulty in question. That way is, to raise the salary of the post to a level commensurate with the importance of the latter

The public interest would suffer if the new Comptroller were to be a man whose lack of the requisite qualifications was only compensated by the possession of influential friends. Particularly would it be undesirable to fill such a post by promotion from the "administrative" or clerical grades of the Civil Service. There is a right place in the scheme of things for the bureaucratic mentality, but that place is not at the head of the Patent Office. While it is true that the business of the State could not be carried on without the meticulous observance of precedent, the mastery of complicated routine, the punctilio of official etiquette which are the special merits of the clerical civil servant, it is equally true that such gifts are not adequate to enlist the confidence of subordinates and of the public on behalf of the chief of a technical office already over-ripe for innovation and development.

Whatever decision may be taken when the time comes, it is earnestly to be hoped that no candidate will even be considered who does not combine with experience of patent practice a thorough training in physical science. It should be an absolutely inviolable principle that an essentially scientific staff should have a man of science at its head.

The Imperial College of Tropical Agriculture.

AT a luncheon at the Mansion House on January 29, given by the Lord Mayor of London and the governing body of the Imperial College of Tropical Agriculture, which is now getting into the swing of its work in Trinidad, Lord Milner's recent appeal for more funds for the endowment of the College was supported by a number of speeches which are of good augury for the future of scientific work in the British tropical colonies.

The Secretary of State for the Colonies (Mr. Amery), in proposing the toast of the College, said that it is an enterprise that holds out great hope in regard to the development of that great imperial asset, the tropical colonies. It is in this light that one should regard it—not as a local affair in Trinidad, but as an Imperial institution, the work of which will have a most important bearing upon the progress of our great tropical Empire This has been much neglected in the past, though it has contributed so much to the wealth of the mother country—through sugar in the West Indies, coffee, coconuts, and tea in India and Ceylon, rubber in Malaya and Ceylon, jute, rice, and many other commodities in India.

From the wetter parts of our tropical possessions we obtain most of our supplies of cacao, cinchona bark for quinine, coconuts and their oil (for soap), copra, coir fibre, coffee, guttapercha, jute (for gunny bags), palm oil (for soap and lubricants), palm fibre (for brushes), rice, rubber, sago, spices, sugar, tea, tapioca, and many fruits, including the banana, and from the drier parts we obtain much tobacco and other products. Tropical Africa now bids fair to go far towards supplying Great Britain with cotton.

Such being the case, one might expect to find much money spent upon the development of the tropical colonies and everything connected with them (especially matters concerned with agriculture and its teaching). In actual fact, their development has largely been effected out of their own revenues, which are in general modest, as they depend mainly upon agriculture. An important departure from this method has recently been made, and the home Government has advanced a large loan to some of the tropical African colonies, with the express object of enabling a rapid development of their systems of transport.

With the great competitive extension of planting and of agriculture generally that is now going on in the tropics, the lack of appreciation of the importance of such an institution as the Imperial College must be due to want of thought. Surely this only needs to be pointed out for some of our wealthy firms and individuals, who have won prosperity from the great industries of rubber, tea, coffee, cotton, coconuts, and other products of the tropics, to come forward with important contributions towards the 100,000*l.* for which Lord Milner has appealed—an endowment to enable the College to make proper use of its great opportunities.

Let it be always remembered that the College is the Imperial College of Tropical Agriculture, and that it is to train men not for Trinidad alone, but for all the widely flung tropical dependencies of the British Empire. It has already received some munificent endowments, but is in need of many more Its land and its largest cash endowment it owes to the Government of Trinidad. It has received machinery to the value of 20,000*l.* from the British Sugar Machinery Manufacturers, and has erected a model sugar factory Messrs. Davidson and Todd, of Port of Spain, have presented the furniture, made of local woods, for the main hall of the College Equipments for rubber, tea, cotton, and others are equally to be desired, and expert staffs are needed to manage them

That important organisations are placing faith in the future value of the College is seen from the fact that the Empire Cotton Growing Corporation, with an executive council composed mainly of Lancashire business men, is sending many of its students to be trained there. These men will have in their hands the chief part in the development of this great industry within the British Empire.

One of the greatest desiderata in the proper opening up of our tropical possessions is a due care for health, and in this connexion it was of great interest to learn from the speech of Sir Arthur Shipley (chairman of the governors) that "the Trustees of the International Health Board (who control the Rockefeller endowments), after careful inquiry into the efficiency and standing of the College, have offered 1000*l.* a year for five years to establish a professorship of tropical sanitation and hygiene", and if this proves a success, Sir Arthur has no doubt that they will continue their benefaction. This still further emphasises the need of the institution for further endowment and equipment.

With the opening of the Imperial College, the older methods of rule of thumb will tend to disappear in the light of modern scientific study, as they have all but disappeared in medicine or surgery. The chance for the young men of to-day, as against their predecessors of thirty years ago, is brighter to an almost incredible degree, provided that men of as good and as capable a type are ready to take advantage of it. Let us wish all prosperity to the Imperial College of Tropical Agriculture under the capable guidance of Dr. Hugh Martin Leake, its new principal, who has lately succeeded to the great pioneer of its fortunes, Sir Francis Watts.

Reminiscences of Great Naturalists.

Impressions of Great Naturalists · Reminiscences of Darwin, Huxley, Balfour, Cope, and others. By Prof. Henry Fairfield Osborn. Pp. xxviii + 216 + 12 plates. (New York and London: Charles Scribner's Sons, 1924.) 12*s.* 6*d* net.

PROF. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, distinguished especially for his palæontological researches, was one of Huxley's students and he also worked under Francis Balfour He met Darwin and corresponded with Wallace, he was friendly with the combative Cope and very intimate with Roosevelt So he has given us his impressions of these and others, selecting a dozen out of the fifty-seven 'appreciations" which he has written in the course of his busy life He has indulged his liking for trying to sum people up; and he has cultivated the gift, he tells us, by studies in heredity and racial characteristics and our ancestors of the Old Stone Age For with his studies there has grown the conviction that "our intellectual, moral, and spiritual reactions are extremely ancient, and that they have been built up not in hundreds but in thousands—perhaps hundreds of thousands—of years" This palæontographical line of thought is very suggestive, thus we think of Pasteur as the supreme avatar of the tanners, and of Roosevelt as the glorification of the hunters; but we do not find that Prof. Osborn has allowed it much expression in his book, unless in "the racial soul of John Burroughs."

We suspect that the greater part of the success of Prof Osborn's pictures is due not to any theoretical background, but simply to the fact that he is a large-hearted, open-minded, big-brained naturalist himself, a generous rather than critical painter, who instinctively looks for what is best in his sitters. If we ever rise to having our portrait painted, we shall hope to have it done by Prof Osborn. But they allow you little say in such matters Here, however, is a truly delightful book of impressions, marked by insight, balanced judgment, and humour.

Wallace's portrait must always be difficult, he was so unequal · with a passion for truth-seeking, yet led astray by will-o'-the-wisps; an observer of the highest rank, yet wasting time in trying to prove to fools that the earth is not flat, a serious ponderer over the mysteries of life, yet often far from clear-cut in his thinking—say, over sex-selection or the possible origin of man's musical talents. One of the noblest men we ever met, one of the foundation-layers of modern biology, yet least wise, we think, when he differed most from Darwin. But the immediate point is that Prof. Osborn gives us a beautiful picture of this great servant of the truth.

Osborn was dissecting a lobster in Huxley's laboratory when Darwin came along and gave him a friendly greeting. "He stands much taller than Huxley, has a very ruddy face, with benevolent blue eyes and overhanging eyebrows. . . . My general impression of his face is very pleasant." He had the eyes of "a man who could survey all nature." Perhaps this last sentence gets to the heart of the matter. Darwin's greatest gift was his capacity for unified vision, for seeing things whole He could take in such a comprehensive landscape that the fallacy of partial views was escaped Doggedly, as he says, he gathered his facts until their multitude would have overwhelmed most men, gathered them and gazed at them and tested them, until the ever-lurking generalisation took the form that fitted and made them one. Whoever has come near Darwin in the all-round comprehensiveness of his picture of the struggle for existence, the inter-relations of organisms, or the processes of selection? The reason why he remains, on the whole, so sound is given by Osborn. "His eyes were the eyes of a man who could survey all nature." He speaks also of their "translucent truthfulness," and in his palæontographical vein he refers to the fact that Darwin came of "a long line of compellingly truthful ancestors" As we expected, Osborn gives a robust answer to the question · How stands it with Darwinism to-day? He indicates the developments of Darwinism that are in progress, including, of course, some corrections, but his general view is that Darwinism is going on and going strong We do not, however, agree that Darwin's supreme service was that "he won for man absolute freedom in the study of the laws of nature," for that halo belongs to no single emancipator.

Prof Osborn is at his best in painting Huxley. He brings out his lucidity, his fighting qualities, his loyalty as "Darwin's bull-dog," his powers of brilliant generalisation, his capacity for taking pains, his passion for veracity. Huxley's discernment of affinities has left many a deep mark on zoology. Here were steps of generalising insight of the highest order, and yet "he never contributed a single original or novel idea" to the Darwinian theory. Prof. Osborn regards this as an expression of Huxley's scientific caution—he could not make up his mind to an ætiology (to use his own word); but perhaps it simply meant that his originality and synthetic power found in morphology and taxonomy all the expression that his busy life would allow.

Francis Maitland Balfour was "the most brilliant and lovable of men," "by far the most balanced mind

among all the English biologists"; he set comparative embryology on its feet. But the picture that is given of him is not more than an elusive sketch. There is more body in the contrasted pictures of Joseph Leidy and Edward Drinker Cope, "the very last representatives in America of the older school of naturalists and anatomists, who covered a very broad field." Leidy was essentially a man of peace, Cope a militant palæontologist. Leidy was an exact observer—a Cuvierian; Cope revelled in speculation, with the strands of Lamarck in his intellectual fabric. Leidy was an evolutionist *sub rosa*; Cope radiated evolution from his eyes.

It is very interesting to see how impartially enthusiastic Osborn is in portraying the divergent excellencies of his old friends. His book contains some good stories, and here is one about Cope. A difference of opinion with his friend Persifor Frazer at the American Philosophical Society "led to such a violent controversy that the two scientists retired to the hallway and came to blows! On the following morning I happened to meet Cope and could not help remarking on a blackened eye. 'Osborn,' he said, 'don't look at my eye. If you think my eye is black, you ought to see Frazer this morning!'" We begin to understand better why Osborn insists that we must go back to the Old Stone Age if we are to understand one another. We are glad to be assured, however, that such differences of opinion did not sever the lifelong friendship.

We wish we had left room to speak of the other portraits: of Roosevelt, with his suggestion of tremendous grip—we remember his hand-shake still—and his accurate knowledge of birds and mammals; of James Bryce, keen botanist and geologist, as well as mountain-climber and historian, who died young at eighty-three; of Howard Crosby Butler, the archæological explorer; of John Burroughs and of John Muir (we are ashamed to confess that we never heard of him before), and of Louis Pasteur, who "showed the way to the physical redemption of man, as Newton had opened to us the new heavens and Darwin the new earth." He should stand as "a symbol of the profound and intimate relation which must develop between the study of nature and the religious life of man." Prof. Osborn's portraits are accompanied by very interesting photographs, and the two series throw light on one another. It is one of the most interesting books we have read for some time, provoking reflection, as well as pride and humility. Our only serious criticism is the author's tendency to be too generous. After all, was there a real genius amongst them—we mean a maker of new knowledge that makes all things new? No doubt Charles Darwin discovered a New World, but there were explorers before him as well as before Columbus, and the doctrine of evolution was not created at Down. They were giants these men here portrayed, but, seriously, when we think of it, would we compare any of them intellectually to Newton or Faraday, to Clerk Maxwell or Kelvin? We doubt if biological science has in the past enthralled any minds of the first order of magnitude, except men like Aristotle, Descartes, and Goethe, who could do everything well. So while Osborn asks if we could nurture a mind like Darwin's to-day, and is inclined to answer in a sad negative, our impression is that we may not unreasonably hope to nurture something even better

J. ARTHUR THOMSON.

Modern Views on Cytology.

General Cytology: a Textbook of Cellular Structure and Function for Students of Biology and Medicine. By Robert Chambers, Edwin G. Conklin, Edmund V. Cowdry, Merle H. Jacobs, Ernest E. Just, Margaret R. Lewis, Warren H. Lewis, Frank R. Lillie, Ralph S. Lillie, Clarence E. McClung, Albert P. Mathews, Thomas H. Morgan, Edmund B Wilson. Edited by Edmund V. Cowdry. Pp. vii+754. (Chicago: University of Chicago Press; London: Cambridge University Press, 1924.) 7.50 dollars.

THIS volume—the largest and most comprehensive ever published on the subject of cytology—will stand for many years to come as the most authoritative exposition of a branch of zoology which has grown considerably in recent years It has been written by the foremost cytologists in the United States of America, altogether thirteen workers, eminent in their special branch, having collaborated. The task of editorship was discharged by E. V. Cowdry.

Such a work could not have been written by one man, and it is obvious that no one reviewer can do justice to such a monument of learning. The present reviewer is keenly aware of this, and would have wished, had it been possible, to have had a sectional review, assisted by English cytologists such as Ward Cutler, Agar, Gray, Ruggles Gates, and Heslop Harrison.

Prof. A. P. Mathews in his section discusses "Chemistry and Psychism," and comes to the conclusion that the creation of life is the creation of the "anakinetomeric form," *i.e.* energy-rich type of substance. Prof. Mathews writes:

"It is in fact the luminiferous ether which has made things alive, for ether is the great storehouse of energy; it is itself nothing else than space and time; energy and time. Energy is but ether divided by time. Quantity of energy is quantity of ether per second. So all goes back to the ether; infinity and eternity. From it is derived our energy and life."

It is impossible for a working cytologist adequately to comment on such passages. They may mean something to the metaphysician, but one cannot help feeling that Prof. Mathews' views on the relationship between cell lipins and cell proteins, or on the biochemistry of development, would have been more useful.

The biochemist writing on the subject of the chromosome theory is always interesting. Prof. Mathews plainly, if cautiously, states that it would be difficult for the biochemist to accept the factorial hypothesis on the evidence of chemical analyses of the chromatinic heads of spermatozoa and other nuclei. He points out that it is very improbable that were the chromosomes constituted of widely different genes, they would show so simple and definite a composition.

This is precisely where modern biochemistry fails: it has not kept up with either genetics or descriptive cytology, and probably never will until microchemical methods are more extensively developed The statement made by Prof. Mathews that the spermatid nucleolus disappears during spermateleosis is without doubt incorrect. What happens is that the nucleolar and chromatinic substances come to stain with equal intensity.

M. H. Jacobs contributes a section on the permeability of the cell to diffusing substances: he deals especially with the modern work on intravital staining, and the penetrating powers of various salts and organic compounds. This article should be of the greatest value to cytologists working with *intra vitam* methods, and the part dealing with the subject of dyes, if short, is particularly pertinent: this chapter, as also many others in this book, shows clearly how indeterminate has been a great deal of recent experimental work. The modern zoological experimenter seems able to produce published papers more quickly than any other of his fellow zoologists; such work, carried on without a proper knowledge of the chemical and physical factors involved, is worse than useless. Jacobs' article shows that there is still a great field for examination in cell permeability, but the searcher *must* be properly equipped. Jacobs refers often to the "Donnan equilibrium."

It would be difficult to set proper boundaries to the subject of the reactivity of the cell. Naturally Ralph S. Lillie's section on this subject is somewhat diffuse and deals with much of his well-known work on the transmission of impulses by protoplasm, and especially with the transmission of nerve impulses. As has been remarked with regard to Jacobs' section, this part by Lillie will certainly be of value to cytologists interested in intravital work, and to protozoologists. The basic work on the irritability of plants, such as that of U. Ricca, R. Snow, and H. H. Dixon, is not mentioned.

The editor of the volume, E. V. Cowdry, has written a section on the mitochondria, Golgi apparatus, and chromidial substance. The article is well balanced if a little histological: the contributions of the English workers on the cytoplasmic inclusions in gametogenesis are adequately mentioned, though the whole question of gametogenesis itself is untouched. This can be forgiven in view of the splendid treatment of the pathological side of this important branch of cytology. So much of our meagre knowledge of the function of the cytoplasmic inclusions has been ascertained by studies on gametogenesis, that it seems a pity that Dr. Cowdry did not include a full treatment of the subject. Some of the controversies regarding the inclusions in gametogenesis would surely have been settled had so distinguished a worker as Cowdry seen fit to enter into the field.

The much-abused Golgi apparatus has at last received official recognition. For this the reviewer at least is thankful. Cowdry mentions that the Golgi apparatus does not occur in non-nucleated red blood corpuscles: it occurs in the red blood corpuscles of reptiles and birds, as has recently been shown. With the possible exception of certain Protozoa, the Golgi bodies have been found in all nucleated animal cells at some time in their life-history.

Warren Lewis and Margaret Lewis are so well known for their work in tissue cultures, that one would be led to expect an authoritative account on this subject; nor are we disappointed. This section contains the best photomicrographs of cells published anywhere. Champy's interesting claims with regard to dedifferentiation of cells cultivated *in vitro* are not substantiated by the Lewises.

The most interesting recent discovery with regard to fertilisation is the process as it occurs in the sponge Grantia Here somatic cells are entered, and the spermatozoon swells up and becomes spherical before it is finally carried to the egg. These facts are not mentioned in Lillie and Just's section on fertilisation, nor are the peculiar examples of precocious fertilisation reviewed The entry of the somatic cells in sponges, mammals, and leeches by spermatozoa is not dealt with; this is a pity, because these facts have a very direct bearing on Lillie's fertilisation theory. The more physical side of fertilisation is adequately treated, but the article as a whole suffers from the fact that the authors have not dealt properly with the work of descriptive cytologists such as Jenkinson on the axolotl.

Conklin contributes a suggestive section on cellular differentiation. Some of the continental work on histogenesis, mentioned in NATURE, February 23, 1924, pp. 276-278, has not come up for review, and the physio-

logical aspect is not dealt with; cell-lineage, a branch of cytology inseparably coupled with Conklin's name, is naturally treated exhaustively. To explain the old question of cellular differentiation, Conklin assumes the presence of differential factors of development lying outside the nucleus, such areas being themselves the immediate result of the interaction of the cytoplasm of the nucleus at an earlier stage. Such an assumption certainly explains partly some forms of development, but not all, and the main question is still unanswered.

In the last two chapters we have an account by McClung of the modern aspects of the chromosome theory, and another section by Morgan dealing with his wonderful work on Mendelian heredity. The recent English work on sex-reversal and the so-called suppression of the sex-chromosome is not properly dealt with, and should be included in the next edition.

Some of the sections gain, others suffer, from the personal theories of the authors. On the whole, the bibliographies are as complete as could be desired, and the illustrations are a feature of the work. The book begins with an introduction by E. B. Wilson, the best-known living cytologist, whose work on "The Cell" has been the students' standby for so many years. In a footnote, Prof. Wilson mentions that he is bringing out a new edition of his work. "General Cytology" is a splendid testimony to the high standard of American science, and cytologists on the eastern side of the Atlantic should be full of admiration and properly grateful for such a splendid volume.

J. BRONTË GATENBY.

General Chemistry.

(1) *Introduction to General Chemistry*. By Prof. William Foster. Pp. vii + 643 + 29 plates. (Princeton: Princeton University Press; London: Oxford University Press, 1924.) 17*s*. 6*d*. net.

(2) *A Laboratory Manual in General Chemistry*. By Prof. William Foster. Pp. ix + 205. (Princeton: Princeton University Press; London: Oxford University Press, 1924.) 10*s*. net.

(1) PROF. FOSTER'S volume was printed in an experimental form two years ago and used by nearly 1000 students before being finally revised for publication. It is a very crowded volume, but at the end of each chapter there are references to the sources of the material, which the student is recommended to read for fuller information. It is no small compliment to English authors that the books cited for this purpose are in the great majority of cases the standard works used in Great Britain. This statement applies, not only to the larger text-books, such as those of Roscoe and Schorlemmer, of Mellor and of Friend, the first of which must have provided the materials for scores of smaller works, but still more frequently to the recent single-volume text-books of Lowry and of Partington, which are repeatedly cited in this way.

The chief fault of the book is its extreme compression, which gives the whole volume the appearance of a reprint of a student's notes on lectures, rather than of the lectures themselves; an independent reader would therefore find the book very tiring, but a student already attending a course of lectures could use it with comfort to supplement his own notes, and to recall in a more authoritative form what he had already been taught by word of mouth. The author has, however, been quite lavish in certain directions, notably in supplying 26 full-plate illustrations of distinguished chemists; these are admirably reproduced, and are in marked contrast to the rough line-drawings in the text, and to the printing, which is on paper of such transparency that it is often possible to read words which are printed on the other side of the sheet, with the result that the pages give the impression of being smudged. In two other cases the text is fuller than in the majority of similar books, since statistics of production are given, for example, for steel and copper, where the United States are at the head of the list; and, in connexion with the metallurgy of copper, the author has allowed himself two full-page photographs and a full-page diagram, in addition to two pages of text, to illustrate the smelting and refining of the metal.

The earlier chapters are, as a rule, provided with a summary, and exercises on the chapters are given throughout, culminating in a series of more than 200 problems at the end of the volume. The diligent student may therefore be expected to have acquired considerable skill by the time that he has completed the course, but the book is designed for "high pressure" work, and "low pressure" readers would probably prefer to choose some less strenuous compilation.

(2) Prof. Foster has also compiled a Laboratory Manual, the material for which has been secured during nearly twenty years of actual teaching, and revised from year to year in such a way as to anticipate every possible misunderstanding on the part of the student. The book concludes with an ingenious "preliminary exercise" on the separation of the metals into groups, in the course of which 24 test-tubes of solutions, arranged in alphabetical order, are attacked successively by the familiar group-reagents. The work of compilation has been done well, and the work will be helpful to other teachers who are responsible for practical classes in elementary chemistry.

Our Bookshelf.

Quantitative Organic Micro-analysis. By Prof. Fritz Pregl. Translated from the second revised and enlarged German edition by Dr. Ernest Fyleman. Pp. xv + 190. (London: J. and A. Churchill, 1924.) 12*s.* 6*d.* net.

THE quantitative analysis of minute amounts of organic solids and liquids is an art (or should we say handicraft?) which owes more to Prof. Pregl than to any other worker, and the award of a Nobel prize to him a few years ago was a fitting tribute to his successful services in this field. At present confined almost exclusively to biochemistry (where it will be useful when the elusive vitamin is isolated), organic micro-analysis has an important future before it.

After devoting a chapter to the Kuhlmann balance, a marvellous instrument which weighs to ± 0·001 mgm. at maximum load (20 gm.), the author describes the determination of carbon and hydrogen, nitrogen, the halogens, sulphur, of arsenic, phosphorus, and copper in organic combination, of the carboxyl, methoxyl, ethoxyl, and methyl groups, and adds a chapter on the determination of molecular weight by the boiling-point method. The weight of material required for each analysis is about 12-15 mgm.

The micro-methods have many points of similarity with the older classical methods of Liebig, Dumas, and Carius, and have obviously been developed from these by dint of tremendous patience and devotion to detail, as well as of unusual practical skill. These newer methods demand a very special technique, the acquisition of which would provide a valuable training to the student after—not before—he has mastered the principles and practice of ordinary analysis. Technique is, as a rule, best learnt in the laboratory from a colleague or instructor, not from a text-book; but in the present case the use of a text-book is fully justified, because organic micro-analysis is still very little known in Great Britain, and also because the directions given by Pregl are so detailed, that it is difficult to conceive how any well-trained chemist could fail to learn from them.

One does not, of course, look for literary skill or grace in a work of this kind; and one does not find them. Like most German technical treatises, the style of this work is heavy, and the translator, of set purpose, has not lightened it. As a literal translation the English version is good, but it would have been much better if the German style had been less rigidly reproduced. "Pregl" is an important work, and both publisher and translator deserve our thanks for having made it available to the increasing number of chemists who either cannot read German, or cannot read it with ease or pleasure.

The Heavens. By J. H. Fabre. Translated by Dr. E. E. Fournier d'Albe. Pp. xvi + 336 + 16 plates. (London: T. Fisher Unwin, Ltd., 1924.) 15*s.* net.

FOR lucidity of style, for simplicity of language, and for felicity in illustration, this book on descriptive astronomy is probably unique. Many passages are quite poetical, as, for example, that (pp. 90, 91) on morning, noon, and night, while the charm of others, such as the concluding paragraphs of the lesson on hour and longitude, lies in their wealth of descriptive allusions. Even the elementary mechanics becomes absorbing when clothed in such vivid language, and the explanation of how the earth is weighed, and of such subjects as parallax, inertia, and centrifugal force, are presented in a most attractive style.

The work is divided into twenty-five lessons, or chapters, and of these all, except three, are concerned with the solar system, and principally with an elementary presentation of its mechanics. There is a preliminary lesson on simple geometry, and by the employment of these "modest geometrical studies" the earth is surveyed, and is weighed, the Cavendish experiment being very clearly explained. It is then girdled with circles of latitude, and with meridians of longitude, its rotation is made clear, and the effects of the illumination of the atmosphere and of the refraction of light are applied. There is also a very good chapter on the calendar. These are specimens of the topics dealt with, and there are also chapters on the sun, the moon, the planets, the comets, the fixed stars, and the nebulæ.

The translation is very well done, and there are several notes by the translator to bring the matter in the text up-to-date. But we think that it would have been an advantage had the translator also edited out-of-date statements in the text, as, for example, that Uranus has eight satellites, that the best method of determining solar parallax is by the transit of Venus, as also the distances in light-years given for some of the stars, which are founded on antiquated data. The name Herschel is always wrongly spelt. There are other obvious slips, probably due to faulty proof-reading.

A. L. C.

British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology, vol. 8, No. 1: *Crustacea.* Part 8: *Euphausiacea.* By Prof. W. M. Tattersall. Pp. 36 + 2 plates. (London: British Museum (Natural History), 1924.) 5*s.*

THERE are very few groups of invertebrate animals of which it can be said with any probability that nearly all the existing species have now been discovered. This claim was made some years ago by Dr. H. J. Hansen as a result of his extensive studies on the Crustacea of the order Euphausiacea. It is supported by the fact that, in the report on the very large collections of this group made by the *Terra Nova* expedition, Prof. Tattersall has not found it necessary to describe a single new species. He discusses the characters and synonymy of a number of the species and describes a series of the larval stages of *Euphausia longirostris*, which is shown to differ from some of its congeners in having a prolonged larval life and in reaching an unusually large size before assuming the adult form. A considerable part of the memoir is devoted to discussing the distribution of the species obtained in the three areas chiefly explored, the Atlantic, the New Zealand region, and the Antarctic and Subantarctic zones south of New Zealand.

It is pointed out that nearly all the specimens were taken in the surface waters at night. During the daytime very few euphausians were taken, and these were, for the most part, larvæ. While a daily vertical migration to and from the deeper strata of the ocean

has been definitely shown to occur for some species, and is probably characteristic of the epiplanktonic species in general, this explanation does not apply to all cases. In coastal waters, euphausians are sometimes observed at the surface in daylight, and their absence from the tow-net catches may be due to their being able to see and avoid the slowly moving tow-nets. The "full speed" nets used on the *Terra Nova* do not seem to have been efficient for the capture of such comparatively large organisms.

Les Insectes parasites de l'homme et des animaux domestiques. Par E. Séguy. (Encyclopédie pratique du Naturaliste, tome 18.) Pp. 442. (Paris: Paul Lechevalier, 1924.) 30 francs.

FRANCE has produced many notable parasitologists, and Brumpt, Neveu-Lemaire, Blanchard, and Ralliet are familiar names of authors of text-books on their subject. M. Séguy is chiefly known as a dipterist, and his studies on mosquitoes have evidently led him to embrace the wider field of parasitology. Although only five orders of insects directly affect man or his domestic animals, a vast literature has grown around them, and the task of treating them at all adequately from the aspect of parasitology is an unusually heavy one. The handbook of M. Séguy is notable as a very concise and practical illustrated epitome of the subject. He has succeeded in compressing within its small compass a really large amount of accurate information.

The Diptera, being the largest order the parasitologist has to contend with, naturally comes in for the major share of treatment. In dealing with this group, the author adopts the heterodox classification of Lameere, who divides the order into only Nemocera and Brachycera. The latter sub-order is made to include the Nemocera Anomala of Osten Sacken, the Brachycera and all the Cyclorrhapha of the more usual systems. This feature renders the section devoted to Diptera rather difficult to follow until one's previous ideas have been readjusted accordingly. The Mallophaga, Anopleura, and Aphaniptera are also adequately dealt with, but among the Hemiptera the Reduviidæ are perhaps dismissed rather too summarily. The book concludes with a well-chosen bibliography of more than 300 references, which, along with the numerous footnotes, includes most of the important sources of information. A. D. I.

The Romance of the Apothecaries' Garden at Chelsea. By Dr. F. Dawtrey Drewitt. Second edition. Pp. 136+15 plates. (London and Sydney: Chapman and Dodd, Ltd., 1924.) 5*s.* net.

How many persons pass daily by the modest botanical garden in Swan Walk, Chelsea, in blissful ignorance of its origin, its antiquity, and the romance attached to it. Dr. Drewitt's charming little work would tell them that it was established about 1673 by the Society of Apothecaries in order that their apprentices might make themselves familiar with the plants used in medicine that, later on, they would be prescribing for their patients. It would give them an insight into the separation of the Apothecaries from the Grocers, of the opposition the new Company had to face, the vicissitudes through which it had to pass, and the sacrifices it had to make to maintain its garden. Dr. Drewitt has understood how to weave into his account much of the changes that London and the surrounding villages have undergone during the last three centuries. He tells us of Johnson, Miller, Sir Hans Sloane, Sir Joseph Banks, and other celebrated men who did so much for the Garden, which attained so high a reputation that, as a letter written by a friend of Linnæus to Miller when curator clearly shows, it was the Apothecaries' Garden which brought Linnæus to London. The second edition of the book contains many additional details concerning the history of the trees in the Garden, so that even any one accustomed to use it for the purposes of study will take a far greater and more intelligent interest in it. The book is most fascinating, and can be read again and again with pleasure and profit.

The Kinetic Theory of Gases. By Prof. Eugène Bloch. Translated by P. A. Smith. Pp. xiv+178. (London: Methuen and Co., Ltd., 1924.) 7*s.* net.

THIS translation, which is taken from Prof. Bloch's work, dated 1921, should meet with a welcome from English readers. The work contains a large amount of information on subjects which commonly find no place in the average text-book. Recent investigations have made the kinetic theory of fluids one of the most vital branches of theoretical physics. Experimental progress has gone hand in hand with the development of theory. There are interesting chapters on statistical mechanics, the theory of quanta, and the Brownian movement and fluctuations. At first sight the width of spectrum lines scarcely seems related to the subject of the book, but the author shows clearly how the width depends on the collisions of the molecules and on their thermal motions. The translator, who has done his work in a very satisfactory manner, has prepared a more complete bibliography of recent papers dealing with the subjects discussed in the various chapters of the book.

Hellenistic Philosophies. By P. E More. (The Greek Tradition from the Death of Socrates to the Council of Chalcedon, 399 B.C. to A.D. 451, Vol. 2.) Pp. v+385. (Princeton: Princeton University Press; London: Oxford University Press, 1923.) 13*s.* 6*d.* net.

THIS is the second volume (the first dealt with the religion of Plato) of a notable comprehensive account of the Greek philosophical tradition. In Mr. More's view, it ends in scepticism, but arises to new life in Christianity. Two other volumes carrying on the tradition are promised. Mr. More writes with ease and distinction and the book is beautifully printed. The absence of an index seriously handicaps it as a book of reference.

Practical Organic Chemistry. By Prof. Julius B. Cohen. Third edition. Pp. xv+520. (London: Macmillan and Co., Ltd., 1924.) 6*s.* 6*d.*

STUDENTS of organic chemistry are indebted to Prof. Cohen for a series of excellent text-books, and this revised edition of his "Practical Organic Chemistry" reaches a high standard. It covers a wide field, including biochemical preparations, and references to the literature are given. A good feature is the very instructive collection of explanatory notes. The book may be recommended as by far the best in any language, and the price is most reasonable.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of Sponge-Spicules.

To account for the extraordinarily beautiful and varied forms of sponge-spicules, with their wonderful symmetry, has long been one of the most puzzling problems of the zoologist After more years of investigation than I care to number, I have arrived at certain conclusions that may interest the readers of NATURE It is, however, a long story, of which I cannot here give more than the barest outline, to be followed, I hope, by a fuller account in another place. For the sake of brevity I must also confine my remarks almost exclusively to siliceous spicules

The generally accepted idea that these spicules arise in "mother-cells" must be abandoned, the so-called mother-cells being, in fact, cells which have enveloped the growing spicule secondarily, after the fashion of phagocytes Their function is either, as silicoblasts, to deposit silica upon the spicules, or, as simple amœbocytes, to carry them from place to place The primary axis around which the silica is deposited is the protorhabd (axial thread), represented in old and eroded spicules by the axial canal. The origin of the protorhabd has hitherto been a complete mystery I believe that it begins as a very minute granule, resembling a micrococcus, capable of movement from place to place, of multiplication by fission, and of growth by elongation and sometimes branching. Regarded as quasi-independent organisms, living symbotically with the sponge, these granules may be termed sclerococci; looked on simply as spicule initiators, they may be termed scleroplastids. Around the usually much elongated scleroplastids, or protorhabds, concentric layers of silica are deposited by silicoblasts, which associate themselves temporarily with the spicules for this purpose, and may exercise a mechanical influence upon their form

The number and arrangement of the rays of the spicule depend upon the number of divisions of the original scleroplastid and the positions which the products of these divisions take up. In the tetract spicule, for example, the original scleroplastid divides into four, which arrange themselves in the form of a pyramid and then elongate centrifugally Secondary growing points may be established by other scleroplastids settling down upon the young spicule and forming new centres of silica deposition.

The evidence on which these conclusions are based can only be summarised in the briefest manner.

(1) In *Stelletta hæckeli* we find many abnormal tetracts (triænes) with more or less suppressed rays, forming a well-graduated reduction series, the protorhabds (still indicated by the axial threads), having been checked in their growth and completely enveloped in silica at various stages of elongation (Fig. 1, 1-5). This reduction series culminates in a perfect sphere of concentrically laminated silica (Fig 1, 6), with a minute granule, representing the original scleroplastid, in the centre. Such spheres are not infrequently met with in siliceous sponges and have been called "siliceous pearls."

(2) Abnormal spicules are often found with adventitious rays developed in unusual situations, and sometimes distinguishable as shafts and cladi. These are to be explained on the hypothesis that wandering scleroplastids settle haphazard on the young spicule and there initiate each its own special kind of ray. In Schmidt's *Stelletta pathologica* nearly all the larger spicules are quite abnormal, formed of rays that have come together apparently by chance, like the members of an Empedoclean monster.

(3) The amphitriæne, which occurs rarely, and usually, if not always, as an abnormality, is readily explicable as a case of incomplete twinning due to abnormal but symmetrical divisions of the original scleroplastid.

(4) I suggested some years ago that in certain spicules with whorled outgrowths the whorls are initiated by groups of "formative" or "initial cells," which settle on the nodes of a vibrating rod, a conclusion which was mathematically supported in a very striking manner by Prof. J. W. Nicholson. These so-called initial cells are really very minute growing points, in each of which a scleroplastid probably forms a centre of attraction for the silica. In the anisodiscorhabds of *Latrunculia bocagei* there are normally two tripartite whorls, each with three growing points. Cases of complete twinning sometimes occur, in which two such spicules, of greatly reduced size, develop

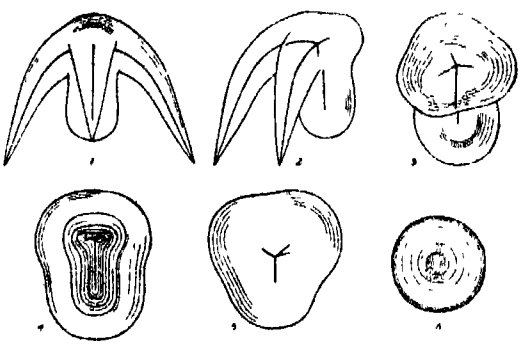


FIG. 1.—Suppressed tetract spicules (triænes) of *Stelletta hæckeli*. × 140.

side by side, but each of these twins has only one whorl. This indicates very clearly that the scleroplastids initiating the two whorls have undergone the usual number of divisions but that their products have distributed themselves over two spicules instead of one.

This last observation seems to me conclusive as to the existence of the scleroplastids as mobile and dividing granules of extremely minute size. The evidence that these are symbiotic organisms (sclerococci) is admittedly less convincing, but seems to me fairly strong.

(1) It is well known that along various lines of phylogenetic descent entire spicule categories mysteriously drop out. Thus we have Stellettids that have lost their triænes, Desmacidonids that have lost their chelæ, and so on. In Chondrilla all the megascleres have disappeared, and in Chondrosia there are no spicules left at all. I was formerly inclined to attribute this loss to the dropping out of Mendelian factors. It may be more simply explained as being due to non-infection by sclerococci

(2) Various cases of the abnormal occurrence of particular types of spicule may be explained by abnormal infection.

(3) In the Euceratosa, with the exception of Darwinella, there are never any spicules at all. Darwinella, however, has, in addition to the normal horny skeleton, radiate spicules composed of spongin, presumably deposited around protorhabds.

(4) In many species of Mycale and Esperiopsis three types of chelæ occur. This may be interpreted to mean that the sclerococci sometimes conjugate and occasionally hybridise, so that we get the two parent

forms of chela and a hybrid. But more evidence is required before this view can be definitely established.

It is difficult to regard the scleroplastids (sclerococci) as genuine constituents of the sponge. They are not nucleated cells but seem to resemble Bacteria in many respects, and I suggest that they are handed on from generation to generation of sponges by egg-infection The sponge converts many of these symbionts into spicules (siliceous, calcareous, or horny as the case may be), and then makes use of the larger ones by building them up into a more or less regular skeleton. The smaller ones it usually makes no use of at all, but either removes them by means of phagocytes or leaves them scattered irregularly through the soft tissues It may be suggested that it is a case of parasitism rather than symbiosis, but evidently the sclerococci are not all destroyed by the sponge, and both parties probably benefit by the association

Experimental investigations by means of inoculation and so forth remain to be attempted, and I hope that this communication may serve to direct attention to a new and promising field of research. The fact that naked sclerococci have not yet been recognised may very well be due to the difficulty of distinguishing them from ordinary Bacteria and from other minute granules with which the tissues of sponges abound ARTHUR DENDY.

King's College, London,
January.

On the Excitation of Spark Spectra.

THE great number of unsuccessful attempts to observe a spark spectrum of lithium have proved the difficulty of exciting, by means of the ordinary methods, the spark spectrum of an element when the excitation potential is high compared with that of the arc spectrum of the same element. Owing to the great interest which is attached not only to the lithium spark spectrum, but also to many other spark spectra which have hitherto not been observed, experiments have been carried on at this Institute during the last two years with the purpose of developing a method which should make it possible to produce spark spectra having a high value of the excitation potential. An apparatus was designed, in which the vapour of the element under investigation was allowed to escape into a high vacuum from a little hole in a crucible, heated by an electric furnace, and where this vapour could be exposed to a bombardment by a strong current of electrons. By evacuating the apparatus to a pressure below 0·001 mm., and by means of a special design of the orifice of the crucible, it was possible to produce and accelerate these electrons, before they could collide with the atoms of the escaping vapour. In the latest construction of the apparatus, the distance from the tungsten filament to the grid was 1-2 mm., the distance from grid to the crucible 10-15 mm., and the electron current was, by means of an anode behind the crucible and a ring near the grid, concentrated on the hole of the crucible where the concentration of vapour was a maximum. The electron current was usually of the order of 200-300 ma, but could without difficulty reach more than 500 ma. Accelerating voltages up to 1400 volts have been applied.

In the first experiments the crucible was filled with easily evaporated metals like sodium, potassium, cadmium, and zinc, and promising results were obtained. Besides the arc spectrum, which was always fully developed with high members of the series, the spark spectra of these elements were observed with considerable intensity at low accelerating potentials of a few hundred volts. Also, with salts in the crucible, spark spectra were in various cases obtained without difficulty.

Owing to the very high boiling-point of metallic lithium and the small dissociation of its salts, it was not found possible in the first apparatus, where the crucible could not be heated above 600°, with this element to produce a sufficient high vapour pressure. With a redesigned apparatus, in which the crucible could be heated to 1000° C., we succeeded, however, in obtaining several lines of the lithium spark spectrum which appeared with considerable intensity with an accelerating voltage of about 300 volts.

While this second apparatus was under construction, Schüler in a recent note (*Die Naturwissenschaften*, July 11, 1924) communicated various important results regarding the lithium spark spectrum, obtained by the beautiful method of the hollow cathode, developed by Paschen. In addition to the line 2934 Å.U., ascribed to lithium by Mohler (*Phys. Rev.*, 23, 108, 1924), Schüler observed a number of new lines which made possible the establishment of the main features of a series scheme with fourfold Rydberg constant, which therefore was ascribed to the singly ionised lithium atom In accordance with the theoretical expectation, that this spectrum should show a great similarity with the ordinary helium spectrum, it was also found possible in the spectrum to recognise two separate series systems At the same time, observations of a number of lines ascribed to the lithium spark spectrum were recorded by M. Morand (*C R*, May 1924) The method of excitation used in his work was that of anode rays While in our experiments only few of the lines given by Morand could be verified, most of Schuler's results were confirmed, although it seemed necessary to introduce small corrections in some of his wave-lengths, and a few modifications in the series scheme proposed The results are stated in the following table, where the wave-lengths are given with an average accuracy of about 0 4 Å.U. The numbers in brackets are the estimated intensities.

TABLE I.

5485·5	(6)	2*s*-2*p*	3200·4	(½)	3*D*-5*F*
4881 5	(1½)	3*p*-4*s*	3196 5	(1)	3*d*-5*f*
4678·1	(1)	3*D*-4*F*	3155·4	(1)	3*p* 5*s*
4672·0	(3)	3*d*-4*f*	3034	(½)	3*P*-5*D* ?
4347	(½)	3*P*-4*D* ?	3029·7	(½)	3*p*-5*d*
4325·7	(2)	3*p*-4*d*	2934 2	(3)	2*S*-2*P* ?
3685 0	(1)	3*s*-4*p*	2729·9	(½)	3*D* 6*F*
3285·8	(1)	3*S*-4*P* ?	2728 9	(1)	3*d*-6*f*
			2612	(½)	3*P*-6*D* ?

Following Schüler, a term notation analogous to that of the helium spectrum is used, the terms denoted by small letters being assumed to correspond with the helium terms of the doublet series, while the terms denoted by capital letters are assumed to correspond with the helium singlet system While most of the lines were rather faint compared with the arc-lines, the line 5485 5 was comparatively bright, and appeared, when observed visually, with about the same intensity as the red and yellow lines of the lithium arc spectrum. This line was originally ascribed by Schüler to the presumed singlet spectrum, but from a more recent observation, kindly communicated to this Institute by Prof. Paschen, that the line in question when observed with high dispersion exhibits a complex structure, Schuler has later concluded that it must belong to the doublet spectrum. This conclusion is also in conformity with our measurements. Not only does it seem impossible in any other way to account for its intensity relative to the other observed lines, but also the absolute value of the wave-length is in complete agreement

with what should be expected from the series relation given in Table I. In fact, this leads to the following scheme of the terms of the doublet spectrum.

TABLE II.

$2s = 134,056$	$(n^* = 1{\cdot}81)$	$2p = 115,831$	$(n^* = 1{\cdot}95)$	$3d = 48,828$	$(n^* = 3{\cdot}00)$	$4f = 27,430$	$(n^* = 4{\cdot}00)$
$3s = 55,308$	$(n^* = 2{\cdot}82)$	$3p = 50,566$	$(n^* = 2{\cdot}95)$	$4d = 27,455$	$(n^* = 4{\cdot}00)$	$5f = 17,552$	$(n^* = 5{\cdot}00)$
$4s = 30,086$	$(n^* = 3{\cdot}82)$	$4p = 28,180$	$(n^* = 3{\cdot}95)$	$5d = 17,569$	$(n^* = 5{\cdot}00)$	$6f = 12,193$	$(n^* = 6{\cdot}00)$
$5s = 18,883$	$(n^* = 4{\cdot}82)$	...		...		...	

The numbers in the brackets are the effective quantum numbers of the various terms. It will be seen that these numbers exhibit a great similarity with those of the helium-doublet spectrum, although the differences from the corresponding hydrogen values are slightly smaller in the case of the lithium spark spectrum, as should also be expected from general theoretical considerations. On account of the smaller number of the observed singlet terms and the great uncertainty attached to their series arrangement, we have confined ourselves to giving in Table I. a preliminary series notation

In addition to the spark spectrum of lithium, the arc spectrum (lithium I-spectrum) was very strongly excited. The sharp and the diffuse series were observed up to the 10th and the 14th member, respectively

No attempt was made to determine the minimum excitation potentials of the spark spectrum lines, but it was observed that between 150 and 200 volts accelerating potential, the intensity of the line 5485 Å.U. decreased very rapidly relative to the arc lines. An increase of accelerating potential from 300 volts to 1000 volts had no effect on the relative intensity of the arc and spark spectrum.

In addition to this method of excitation by means of impacting electrons, the lithium spark lines were also obtained under somewhat different conditions. If the vapour pressure was high and the potential between the crucible and the anode was more than 500 volts, then under the electron bombardment an arc would strike between the crucible and anode, and this arc would continue even after the electron current was cut off. This arc, in which the potential drop was 400-500 volts, and the current 400-500 ma, showed a brilliant luminescence and exhibited besides the ordinary arc lines also the spark lines, especially the line 5485 Å.U., with considerable intensity. However, excited in this way, the relative intensity of the spark spectrum compared with the arc spectrum is much smaller than when the spectra were excited by means of electron bombardment. The work will be continued.

The writer wishes to express his thanks to Dr J. A Christiansen, in collaboration with whom the first apparatus was designed, but who was prevented from taking part in the further developing of the work.

SVEN WERNER.
Universitetets Institut for teoretisk Fysik,
Copenhagen, January 6

Rainfall Correlations in Trinidad.

AN important feature of modern economic geography is the study of the relationship between climatic conditions and industry. Regarding climate and weather as being respectively the static and dynamic aspects of meteorological conditions, we have in the tropics, as Dr. Martin Leake has recently emphasised, climate a determinate factor in the location of industries and colonies of people; weather, on the other hand, is frequently the most important factor underlying local industrial *variation*. In the tropics, rainfall is generally the chief weather factor affecting crop yields, and in Trinidad (West Indies) the writer has given some attention to the relationship between variation in rainfall and yield of cacao—the island's principal product. This work has definitely established the fact that the annual variations in yield, which may deviate as much as −101·8 per cent. of a 5-year moving average (River Estate, 1921–22), are fundamentally due to variations in rainfall, though the exact extent of the connexion has not been statistically determined in all cases.

The procedure followed in the investigation was to obtain monthly rainfall and monthly crop-yield records for as many years back as possible (generally not more than 15) from the most reliable individual estates, and to work on the data for each estate separately. Finally, the annual output of cacao for the whole island was considered in relation to the average annual rainfall for all cacao districts. On the whole, I am satisfied that the data obtained are sufficiently trustworthy for the purpose of affording general indications.

It will be well to emphasise, however, that studies like the present one cannot be regarded as purely statistical. we are dealing, not with the rainfall itself but with its ultimate effects, and it is necessary to have at least an elementary knowledge of the physiological nature and habits of the cacao tree (in this particular study) in order to anticipate lags and to deal intelligently in general with the data. There is also the question of increasing or declining output as affected by agricultural management. The latter difficulty is partly overcome by plotting the yield deviations from moving averages for, say, 5-year periods. In general the "dot chart" method of plotting yield against rainfall to indicate linear correlation was employed, and in cases where the points clustered adequately, the coefficient of correlation was computed. In all cases the percentage deviations from the averages were plotted as well, in order to compare the magnitude of the variations on the same scale. It is not possible in this short note to reproduce the graphs and all the computations, but they are available for reference. The following table gives the general conclusions arrived at:

Estate.	Geographical location.	Av. ann. rainfall in. (approx.)	Correlation: Yield and rain of "wet" months.	Correlation: Yield and Nov. rain.
La Vega	Central Range	84	Negative	None
Non Pareil	East end of N. Range	95	Negative	Positive
Verdant Vale	Central N Range	85	Negative	Positive
River	West end of N. Range	67	(Inconclusive)	(Inconclusive)
All cacao Districts	North, Central and S.E.	73 (weighted)	Positive within limits	(Undetermined)

It would appear that estates with an average annual rainfall of 80 inches and more are less adapted for cacao, other things being equal, than estates with an average annual rainfall lying between 70 and 75 inches. In the case of La Vega estate the negative correlation was found to be extremely definite, the highest and most remarkable coefficient being in respect of the May and June rainfall and the subsequent crop. This was found to be $-0{\cdot}95 \pm 0{\cdot}10$. It is necessary to mention that this computation was made under my direction but that I have not verified it. For the rainfalls of May only, however, and subsequent yields, I myself obtained a coefficient of $-0{\cdot}85 \pm 0{\cdot}15$, which is equally, if not more surprising, because it refers to one month of the year only, and that six months prior to the coming in of the crop affected.

Verdant Vale estate has a coefficient for November rain of 0·65±0·05. The apparent importance of adequate rain during November in the Northern Range of hills is interesting, and this and many other points require further study.

Generally speaking, rainfall seems to be a fundamental factor underlying the whole economic activity of Trinidad. A close connexion was found by the writer between rainfall in Port of Spain and the electric tram-car takings, and between the business done in the shops The latter is partly due to synchronic weather changes, and partly the effect of the previous year's rainfall and crop yields affecting the purchasing power of the inhabitants.

On the principal rubber estate I found the well-known connexion between daily rainfall and the quantity of rubber tapped from the trees The connexion here is due to purely physical reasons, rain causing the latex to flow over the bark instead of down the central channel into the cup. The influence of rainfall on sugar-cane and coconut yields was not studied, but it may be of interest to mention that considerable work on the former relationship has been done in other countries. The most important, perhaps, of this work is A. Walter's analysis of climatic factors and the cane crop in Mauritius, that of M. Kœnig in the same Colony, and the work of T. A. Tengwall and C. E. van de Zyl in Java, which has recently established a positive correlation between sugar yield per bouw and amount of rain in October and November. A very good summary of the results obtained in the United States in regard to weather factors and cotton, Indian corn (maize) and tobacco, is to be found in J. W. Smith's "Agricultural Meteorology." Most of the correlations obtained in connexion with rainfall and tropical and sub-tropical crops have been in the neighbourhood of 0·60 with probable errors indicating a fair degree of significance.

In conclusion, I should like to emphasise the importance of this work not only from the point of view of physiology and agriculture, but also from the wider point of view of economic geography. Conditions in tropical countries have, for the most part, been fully described, what is needed now is statistical analysis and co-ordination, and from a broad administrative point of view. In Trinidad the general complaint is that short cacao crops are due to drought. On many of the best and largest estates my work indicates that the trouble is the result—or partly the result—of too much rain. W. R. DUNLOP.

34 Kensington Court, W.8.

Astrophysics without Mathematics.

SIR JOSEPH HOOKER in 1869, in undertaking to review a book for a journal of science, made the following remark: "I hope that . . . will give us better analyses of books than reviews in general afford us. We have no end of reviews, but they are generally the author's views on the subject of the book to be reviewed and convey no precise information as to the books themselves. This is a crying evil." The review by "E. A. M." in NATURE of January 10 of my book, "Modern Astrophysics," is a particularly good specimen of the type of review to which Hooker very properly took exception. The reader of this review who has not seen the book will have not the remotest idea of what I have tried to do, or of the intended (E. A. M. calls the book "amorphous") structure of the book as revealed, say, by the titles of its sections and chapters. Instead of this relevant and, one would have thought, indispensable matter, he is treated to a catalogue of E. A. M.'s misapprehensions of the subject and of his differences from me in matters of opinion.

The book is condemned from the literary point of view; it is implied that it is difficult to comprehend; and a large number of "omissions" and "errors" are selected as examples of "looseness" of reasoning. With regard to the first two points, E. A M 's remarks, when examined, condemn themselves, and need no comment. He is entitled to his opinion, which he is unfortunate enough not to share with a single one of the critics whose qualifications to review the book are of a literary character. I wish only to remark that E A. M. has either not read or forgotten the preface to the book, and that his statement that the reader "is conducted twice round the whole existing observational material" is untrue.

The main part of the "review" is occupied with criticisms of points of detail E A M. has evidently been peering into the book in order to make a collection of all the trivial points to which he can object, and as a result he puts forward eleven points of this kind. The reader of the "review" will probably be surprised to learn that the whole of the material in the book dealing with all except one of the points criticised by E. A. M., when put together, would make up almost exactly one page The material dealing with the remaining point occupies four and a half pages The book contains about 475 pages

It is clearly an abuse of a reviewer's authority to concentrate on points of this kind, even if his criticisms on those points are valid. E A. M., however, has not even that excuse. The only criticism in which I admit he is justified is that I have omitted to describe the general method of determining cluster parallaxes. For pointing out that omission I am indebted to him. On the other matters I have written to him personally, pointing out where he has blundered If, after reading my letter, he so wishes, I am quite prepared to discuss any or all of the points with him when, where, and in whatever reasonable manner he may choose, in public or in private. Considering the tone in which his "review" is written, it is incumbent upon him to accept this offer or to withdraw his remarks at once.

It is very unpleasant to have to reply to a review, but the misrepresentation and tone of E A. M 's essay leave me no alternative in the interests of the truth I have tried to present in my book

HERBERT DINGLE.

Imperial College of Science and Technology,
January 15, 1925.

I AM sorry that my review has caused Prof Dingle so much pain; and I must beg him to accept my assurance that purely scientific considerations were in my mind. My review contains evidence that there were portions of the book which I read with pleasure, and I take this occasion to say so explicitly. I cannot see that my criticisms were outside the province of a reviewer, but I deeply regret that they should have been expressed in language which Prof. Dingle finds discourteous.

With regard to the substance of my criticisms in the main part of the review, I should not have made them unless I were fully prepared to justify them. After carefully examining the arguments brought forward by Prof. Dingle in his personal letter to me, I am unable to withdraw any of the ten points to which he objects, but I am willingly availing myself of the opportunity of discussing them with him privately. I am unable to agree with Prof. Dingle that the points raised are trivial. They all seemed to me either to be of fundamental importance in themselves or to involve fundamental principles.

E. A. MILNE.

Trinity College, Cambridge.

The Structure of the so-called Ultraviolet Bands of Water Vapour.

THE so-called ultraviolet bands of water vapour, which must probably be attributed to the OH-molecule,[1] have been the object of an extensive study. Heurlinger[2] succeeded in arranging almost all the lines of the band λ 3064 into 12 branches which he called P_1^k, Q_1^k, R_1^k, P_2^k, Q_2^k, R_2^k ($k = 1, 2$). But it was not possible to give a theoretical interpretation of the bands, and to decide to which quantum states of the molecule the lines belong.[3] Recently, Watson[4] measured the band λ 2811 and showed that it has exactly the same structure as the band λ 3064. These measurements, combined with those of Grebe and Holtz of the band λ 3064, enable us to get a complete insight into the structure of these bands. With the aid of the combination principle it is possible to get the relative values of the rotational terms without any theoretical assumption about the structure of the molecule. The results obtained are summarised below. (Details will be published in the Proc. Roy. Acad. Amsterdam.)

(1) The six branches P_i^1, Q_i^1, R_i^1 ($i = 1, 2$) form one band which we shall denote by I, and the branches P_i^2, Q_i^2, R_i^2 another band (II), so that what is called a band consists in reality of two bands, which must be attributed to different oscillation transitions; *e.g.*

	I	II
λ 3064	0 → 0	1 → 1
λ 2811	1 → 0	2 → 1

(the transition 0 → 0 for λ 3064 I is chosen arbitrarily). Then λ 2811 I and λ 3064 II must have the same initial state, which is confirmed by the combination principle. That the bands λ 3064 and λ 2811 have the same final state was already pointed out by Watson.

(2) The six branches of one band must be represented by the following scheme.

$$\begin{array}{ll} P_1(m) = F_1(m-1) - f_1(m) & P_2(m) = F_2(m-1) - f_2(m) \\ Q_1(m) = F_1(m) - f_1'(m) & Q_2(m) = F_2(m) - f_2'(m) \\ R_1(m) = F_1(m+1) - f_1(m) & R_2(m) = F_2(m+1) - f_2(m), \end{array}$$

which is derived from the relations—

$$\left.\begin{array}{l} Q_i(m) - P_i(m+1) \\ R_i(m) - Q_i(m+1) \end{array}\right\} \text{are the same for } \lambda\,3064 \text{ and } \lambda\,2811$$

$R_i(m) - P_i(m)$ are the same for λ 3064 II and λ 2811 I

$Q_i(m) - P_i(m+1) \neq R_i(m) - Q_i(m+1)$ in one band.

(3) As is well known, the lines do not follow Deslandres's rule for small values of m. There must therefore be a component of the electronic impulse along the axis of figure as well as one perpendicular to it.[5] The terms cannot be represented by the formula of Kramers and Pauli, or by the modification of it with which Kratzer[6] succeeded in representing the terms of the (C + H) bands. This shows that the electronic impulse cannot be connected quasi-rigidly with the molecule. It seems that the electronic impulse has a precession which increases with growing m.

(4) Fortrat[7] showed that most of the lines are accompanied by satellites. It is very probable that these satellites arise from the same quantum states of the molecule as the lines themselves, which indicates that they are also combinations between the terms given above. The three satellites of Q_2 are then, for example,

$$F_1(m) - f_2'(m) \qquad F_1(m) - f_2(m) \qquad F_2(m) - f_2(m)$$

The precision of the measurements, however, does not permit of deciding this question with certainty. It is not impossible that there are other terms slightly different from the former ones which are responsible for the satellites.

G. H. DIEKE.

Instituut voor theoretische natuurkunde,
Leyden.

[1] W. W. Watson, *Astroph. Journal*, 60, p. 145 (1924).
[2] T. Heurlinger, "Untersuchungen über die Struktur der Bandenspektra," Lund, 1918.
[3] Cf. A. Sommerfeld, "Atombau und Spektrallinien," 3rd ed. p. 527.
[4] H. A. Kramers and W. Pauli, *Zeit. f. Phys.*, 13, p. 351 (1923).
[5] A. Kratzer, *Zeit. f. Phys.*, 23, p. 298 (1924).
[6] R. Fortrat, *Journal de Phys.*, 5, p. 20 (1924).

Hafnium Oxide in Tungsten Filaments.

IT has been known for a long time that perfectly pure tungsten cannot be used for the manufacture of filaments for electric lamps on account of its "off-setting" structure due to recrystallisation. It has been found also that recrystallisation can be essentially influenced by suitable additions. Thus, for example, thorium oxide or silicon oxide can be used with good results.

By mixing tungsten oxide with a solution of hafnium nitrate, evaporating the latter to dryness, heating the product obtained and reducing it then with hydrogen, tungsten powder is formed, having a definite content of hafnium oxide. In my experiments the latter was comprised between 0·1 and 3 per cent.

During the subsequent sintering operation in hydrogen to which the compressed and heated rod is submitted, a small part of the hafnium oxide is reduced, and the hafnium produced combines with the tungsten. During the subsequent swaging operation, this formation of a solid solution causes difficulties which can be easily obviated by using nitrogen or rare gases instead of hydrogen. In this case the swaging and drawing operation is readily effected.

The hafnium oxide is distinguished by its high melting-point and its low vapour pressure at high temperatures, so that it has proved to be a suitable addition to tungsten for filaments. The vapour tension at the temperature of the sintering operation is so low that no evaporation whatever of hafnium oxide could be ascertained.

J. A. M. VAN LIEMPT.

Physical Chemistry Laboratory,
Philips' Glowlamp Works, Ltd.,
Eindhoven (Holland).

Citrus Fruit and Scurvy.

IN "Purchas his Pilgrimage or Relations of the World and the Religions observed in al Ages and Places discovered" there are some interesting references to the disease scurvy. The edition I possess is the third, dated 1617; our Public Library in Melbourne having only the fourth, dated 1626.

On page 865 of this third edition the following statement occurs: "The Scorbute so weakened their men, that they were not able to hoise (*sic*) out their boats, except in the Generalls ship, whose men (drinking euery morning three spoonefuls of the iuice of Limons) were healthfull."

Again, on page 1086 there is a description of scurvy with a marginal printed note as follows: "Oranges, Limons, and the like are excellent remedies to this disease."

I regret I have not access to the first and second editions of the work, but as it is, this surely constitutes one of the earliest references to the citrus cure or prevention of scurvy.

W. A. OSBORNE.

The University of Melbourne,
December 9.

Australopithecus africanus: The Man-Ape of South Africa.

By Prof. RAYMOND A. DART, University of the Witwatersrand, Johannesburg, South Africa.

TOWARDS the close of 1924, Miss Josephine Salmons, student demonstrator of anatomy in the University of the Witwatersrand, brought to me the fossilised skull of a cercopithecid monkey which, through her instrumentality, was very generously loaned to the Department for description by its owner, Mr. E. G. Izod, of the Rand Mines Limited. I learned that this valuable fossil had been blasted out of the limestone cliff formation—at a vertical depth of 50 feet and a horizontal depth of 200 feet—at Taungs, which lies 80 miles north of Kimberley on the main line to Rhodesia, in Bechuanaland, by operatives of the Northern Lime Company. Important stratigraphical evidence has been forthcoming recently from this district concerning the succession of stone ages in South Africa (Neville Jones, Jour. Roy. Anthrop. Inst., 1920), and the feeling was entertained that this lime deposit, like that of Broken Hill in Rhodesia, might contain fossil remains of primitive man.

I immediately consulted Dr. R. B. Young, professor of geology in the University of the Witwatersrand, about the discovery, and he, by a fortunate coincidence, was called down to Taungs almost synchronously to investigate geologically the lime deposits of an adjacent farm. During his visit to Taungs, Prof. Young was enabled, through the courtesy of Mr. A. F. Campbell, general manager of the Northern Lime Company, to inspect the site of the discovery and to select further samples of fossil material for me from the same formation. These included a natural cercopithecid endocranial cast, a second and larger cast, and some rock fragments disclosing portions of bone. Finally, Dr. Gordon D. Laing, senior lecturer in anatomy, obtained news, through his friend Mr. Ridley Hendry, of another primate skull from the same cliff. This cercopithecid skull, the possession of Mr. De Wet, of the Langlaagte Deep Mine, has also been liberally entrusted by him to the Department for scientific investigation.



FIG. 1.—Norma facialis of *Australopithecus africanus* aligned on the Frankfort horizontal.

The cercopithecid remains placed at our disposal certainly represent more than one species of catarrhine ape. The discovery of Cercopithecidæ in this area is not novel, for I have been informed that Mr. S. Haughton has in the press a paper discussing at least one species of baboon from this same spot (Royal Society of South Africa). It is of importance that, outside of the famous Fayûm area, primate deposits have been found on the African mainland at Oldaway (Hans Reck, *Sitzungsbericht der Gesellsch. Naturforsch. Freunde*, 1914), on the shores of Victoria Nyanza (C. W. Andrews, *Ann. Mag. Nat. Hist.*, 1916), and in Bechuanaland, for these discoveries lend promise to the expectation that a tolerably complete story of higher primate evolution in Africa will yet be wrested from our rocks.

In manipulating the pieces of rock brought back by Prof. Young, I found that the larger natural endocranial cast articulated exactly by its fractured frontal extremity with another piece of rock in which the broken lower and posterior margin of the left side of a mandible was visible. After cleaning the rock mass, the outline of the hinder and lower part of the facial skeleton came into view. Careful development of the solid limestone in which it was embedded finally revealed the almost entire face depicted in the accompanying photographs.

It was apparent when the larger endocranial cast was first observed that it was specially important, for its size and sulcal pattern revealed sufficient similarity with those of the chimpanzee and gorilla to demonstrate that one was handling in this instance an anthropoid and not a cercopithecid ape. Fossil anthropoids have not hitherto been recorded south of the Fayûm in Egypt, and living anthropoids have not been discovered in recent times south of Lake Kivu region in Belgian Congo, nearly 2000 miles to the north, as the crow flies.

All fossil anthropoids found hitherto have been known only from mandibular or maxillary fragments, so far as crania are concerned, and so the general appearance of the types they represented has been unknown; consequently, a condition of affairs where virtually the whole face and lower jaw, replete with teeth, together with the major portion of the brain pattern, have been preserved, constitutes a specimen of unusual value in fossil anthropoid discovery. Here, as in *Homo rhodesiensis*, Southern Africa has provided documents of higher primate evolution that are amongst the most complete extant.

Apart from this evidential completeness, the specimen is of importance because it exhibits an extinct race of apes *intermediate between living anthropoids and man*.

In the first place, the whole cranium displays *humanoid* rather than anthropoid lineaments. It is markedly dolichocephalic and leptoprosopic, and manifests in a striking degree the *harmonious relation* of calvaria to face emphasised by Pruner-Bey. As Topinard says, "A cranium elongated from before backwards, and at the same time elevated, is already in harmony by itself; but if the face, on the other hand, is elongated from above downwards, and narrows, the harmony is complete." I have assessed roughly the difference in the relationship of the glabella-gnathion facial length to the glabella-inion calvarial length in recent African anthropoids of an age comparable with that of this specimen (depicted in Duckworth's "Anthropology and Morphology," second edition, vol. i.), and find that, if the glabella-inion length be regarded in all three as 100, then the glabella-gnathion length in the young chimpanzee is approximately 88, in the young gorilla 80, and in this fossil 70, which proportion suitably demonstrates the enhanced

relationship of cerebral length to facial length in the fossil (Fig. 2)

The glabella is tolerably pronounced, but any traces of the salient supra-orbital ridges, which are present even in immature living anthropoids, are here entirely absent. Thus the relatively increased glabella-inion measurement is due to brain and not to bone. Allowing 4 mm for the bone thickness in the inion region, that measurement in the fossil is 127 mm.; *i.e.* 4 mm. less than the same measurement in an adult chimpanzee in the Anatomy Museum at the University of the Witwatersrand. The orbits are not in any sense detached from the forehead, which rises steadily from their margins in a fashion amazingly human The interorbital width is very small (13 mm.) and the ethmoids are not blown out laterally as in modern African anthropoids This lack of ethmoidal expansion causes the lacrimal fossæ to face posteriorly and to lie relatively far back in the orbits, as in man The orbits, instead of being subquadrate as in anthropoids, are almost circular, furnishing an orbital index of 100, which is well within the range of human variation (Topinard, "Anthropology"). The malars, zygomatic arches, maxillæ, and mandible all betray a delicate and humanoid character The facial prognathism is relatively slight, the gnathic index of Flower giving a value of 109, which is scarcely greater than that of certain Bushmen (Strandloopers) examined by Shrubsall The nasal bones are not prolonged below the level of the lower orbital margins, as in anthropoids, but end above these, as in man, and are incompletely fused together in their lower half. Their maximum length (17 mm) is not so great as that of the nasals in *Eoanthropus dawsoni* They are depressed in the median line, as in the chimpanzee, in their lower half, but it seems probable that this depression has occurred post-mortem, for the upper half of each bone is arched forwards (Fig 1). The nasal aperture is small and is just wider than it is high (17 mm × 16 mm.) There is no nasal spine, the floor of the nasal cavity being continuous with the anterior aspect of the alveolar portions of the maxillæ, after the fashion of the chimpanzee and of certain New Caledonians and negroes (Topinard, *loc. cit*).

In the second place, the dentition is *humanoid* rather than anthropoid The specimen is juvenile, for the

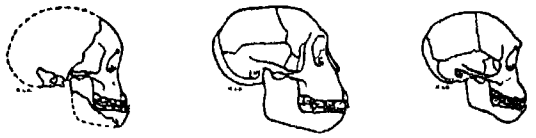


FIG. 2.—Cranial form in living anthropoids of similar age (after Duckworth) and in the new fossil For this comparison, the fossil is regarded as having the same calvarial length as the gorilla.

first permanent molar tooth only has erupted in both jaws on both sides of the face; *i.e.* it corresponds anatomically with a human child of six years of age. Observations upon the milk dentition of living primates are few, and only one molar tooth of the deciduous dentition in one fossil anthropoid is known (Gregory, "The Origin and Evolution of the Human Dentition," 1920). Hence the data for the necessary comparisons are meagre, but certain striking features of the milk dentition of this creature may be mentioned. The tips of the canine teeth transgress very slightly (0·5-0·75 mm) the general margin of the teeth in each jaw, *i.e.* very little more than does the human milk canine. There is no diastema whatever between the premolars and canines on either side of the lower jaw, such as is present in the deciduous dentition of living anthropoids; but the canines in this jaw come, as in the human jaw, into alignment with the incisors (Gregory, *loc. cit.*). There is a diastema (2 mm on the right side, and 3 mm. on the left side) between the canines and lateral incisors of the upper jaw, but seeing, first, that the incisors are narrow, and, secondly, that diastemata (1 mm-1·5 mm) occur between the central incisors of the upper jaw and between the medial and lateral incisors of both sides in the lower jaw, and, thirdly, that some separation of the milk teeth takes place even in mankind (Tomes, "Dental Anatomy," seventh edition) during the establishment of the permanent dentition, it is evident that the diastemata which occur in the upper jaw are small. The lower canines, nevertheless, show wearing facets both for the upper canines and for the upper lateral incisors.



FIG. 3.—Norma lateralis of *Australopithecus africanus* aligned on the Frankfort horizontal.

The incisors as a group are irregular in size, tend to overlap one another, and are almost vertical, as in man; they are not symmetrical and well spaced, and do not project forwards markedly, as in anthropoids. The upper lateral incisors do project forwards to some extent and perhaps also do the upper central incisors very slightly, but the lateral lower incisors betray no evidence of forward projection, and the central lower incisors are not even vertical as in most races of mankind, but are directed slightly backwards, as *sometimes* occurs in man Owing to these remarkably human characters displayed by the deciduous dentition, when contour tracings of the upper jaw are made, it is found that the jaw and the teeth, as a whole, take up a parabolic arrangement comparable only with that presented by mankind amongst the higher primates. These facts, together with the more minute anatomy of the teeth, will be illustrated and discussed in the memoir which is in the process of elaboration concerning the fossil remains.

In the third place, the mandible itself is *humanoid* rather than anthropoid. Its ramus is, on the whole, short and slender as compared with that of anthropoids, but the bone itself is more massive than that of a human being of the same age. Its symphyseal region is virtually complete and reveals anteriorly a more vertical outline than is found in anthropoids or even in the jaw of Piltdown man. The anterior symphyseal surface is scarcely less vertical than that of Heidelberg man. The posterior symphyseal surface in living

anthropoids differs from that of modern man in possessing a pronounced posterior prolongation of the lower border, which joins together the two halves of the mandible, and so forms the well-known *simian shelf* and above it a deep genial impression for the attachment of the tongue musculature In this character, *Eoanthropus dawsoni* scarcely differs from the anthropoids, especially the chimpanzee; but this new fossil betrays no evidence of such a shelf, the lower border of the mandible having been massive and rounded after the fashion of the mandible of *Homo heidelbergensis*.



FIG 4.—Norma basalis of *Australopithecus africanus* aligned on the Frankfort horizontal

That hominid characters were not restricted to the face in this extinct primate group is borne out by the relatively forward situation of the foramen magnum. The position of the basion can be assessed within a few millimetres of error, because a portion of the right exoccipital is present alongside the cast of the basal aspect of the cerebellum Its position is such that the basi-prosthion measurement is 89 mm, while the basi-inion measurement is at least 54 mm This relationship may be expressed in the form of a "head-balancing" index of 60·7. The same index in a baboon provides a value of 41·3, in an adult chimpanzee 50·7, in Rhodesian man 83 7, in a dolichocephalic European 90·9, and in a brachycephalic European 105 8. It is significant that this index, which indicates in a measure the poise of the skull upon the vertebral column, points to the assumption by this fossil group of an attitude appreciably more erect than that of modern anthropoids. The improved poise of the head, and the better posture of the whole body framework which accompanied this alteration in the angle at which its dominant member was supported, is of great significance. It means that a greater reliance was being placed by this group upon the feet as organs of progression, and that the hands were being freed from their more primitive function of accessory organs of locomotion. Bipedal animals, their hands were assuming a higher evolutionary rôle not only as delicate tactual, examining organs which were adding copiously to the animal's knowledge of its physical environment, but also as instruments of the growing intelligence in carrying out more elaborate, purposeful, and skilled movements, and as organs of offence and defence. The latter is rendered the more probable, in view, first, of their failure to develop massive canines and hideous features, and, secondly, of the fact that even living baboons and anthropoid apes can and do use sticks and stones as implements and as weapons of offence ("Descent of Man," p. 81 *et seq.*).

Lastly, there remains a consideration of the endocranial cast which was responsible for the discovery of the face. The cast comprises the right cerebral and cerebellar hemispheres (both of which fortunately meet the median line throughout their entire dorsal length) and the anterior portion of the left cerebral hemisphere. The remainder of the cranial cavity seems to have been empty, for the left face of the cast is clothed with a picturesque lime crystal deposit; the vacuity in the left half of the cranial cavity was probably responsible for the fragmentation of the specimen during the blasting. The cranial capacity of the specimen may best be appreciated by the statement that the length of the cavity could not have been less than 114 mm., which is 3 mm. greater than that of an adult chimpanzee in the Museum of the Anatomy Department in the University of the Witwatersrand, and only 14 mm less than the greatest length of the cast of the endocranium of a gorilla chosen for casting on account of its great size Few data are available concerning the expansion of brain matter which takes place in the living anthropoid brain between the time of eruption of the first permanent molars and the time of their becoming adult. So far as man is concerned, Owen ("Anatomy of Vertebrates," vol iii) tells us that "The brain has advanced to near its term of size at about ten years, but it does not usually obtain its full development till between twenty and thirty years of age" R Boyd (1860) discovered an increase in weight of nearly 250 grams in the brains of male human beings after they had reached the age of seven years It is therefore reasonable to believe that the adult forms typified by our present specimen possessed brains which were larger than that of this juvenile specimen, and equalled, if they did not actually supersede, that of the gorilla in absolute size

Whatever the total dimensions of the adult brain may have been, there are not lacking evidences that the brain in this group of fossil forms was distinctive in type and was an instrument of greater intelligence that that of living anthropoids. The face of the endocranial cast is scarred unfortunately in several places (cross-hatched in the dioptographic tracing—see Fig. 5). It is evident that the relative proportion

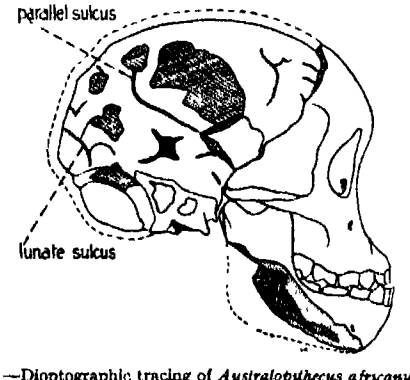


FIG 5.—Dioptographic tracing of *Australopithecus africanus* (right side), × ½

of cerebral to cerebellar matter in this brain was greater than in the gorilla's. The brain does not show that general pre- and post-Rolandic flattening characteristic of the living anthropoids, but presents a rounded and well-filled-out contour, which points to a symmetrical and balanced development of the faculties of associative memory and intelligent activity. The pithecoid type of parallel sulcus is preserved, but the sulcus lunatus has been thrust backwards towards the occipital pole by a pronounced general

bulging of the parieto-temporo-occipital association areas.

To emphasise this matter, I have reproduced (Fig. 6) superimposed coronal contour tracings taken at the widest part of the parietal region in the gorilla endocranial cast and in this fossil. Nothing could illustrate better the mental gap that exists between living anthropoid apes and the group of creatures which the fossil represents than the flattened atrophic appearance of the parietal region of the brain (which lies between the visual field on one hand, and the tactile and auditory fields on the other) in the former and its surgent vertical and dorso-lateral expansion in the latter The expansion in this area of the brain is the more significant in that it explains the posterior *humanoid* situation of the sulcus lunatus It indicates (together with the narrow interorbital interval and human characters of the orbit) the fact that this group of beings, having acquired the faculty of stereoscopic vision, had profited beyond living anthropoids by setting aside a relatively much larger area of the cerebral cortex to

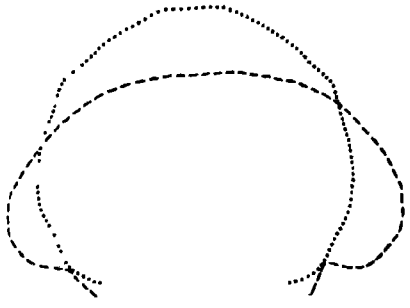


FIG. 6.—Contour tracings of coronal sections through the widest part of the parietal region of the endocranial casts in Australopithecus .... and in a gorilla ----

serve as a storehouse of information concerning their objective environment as its details were simultaneously revealed to the senses of vision and touch, and also of hearing They possessed to a degree unappreciated by living anthropoids the use of their hands and ears and the consequent faculty of associating with the colour, form, and general appearance of objects, their weight, texture, resilience, and flexibility, as well as the significance of sounds emitted by them In other words, their eyes saw, their ears heard, and their hands handled objects with greater meaning and to fuller purpose than the corresponding organs in recent apes They had laid down the foundations of that discriminative knowledge of the appearance, feeling, and sound of things that was a necessary milestone in the acquisition of articulate speech.

There is, therefore, an ultra-simian quality of the brain depicted in this immature endocranial cast which harmonises with the ultra-simian features revealed by the entire cranial topography and corroborates the various inferences drawn therefrom. The two thousand miles of territory which separate this creature from its nearest living anthropoid cousins is indirect testimony to its increased intelligence and mastery of its environment It is manifest that we are in the presence here of a pre-human stock, neither chimpanzee nor gorilla, which possesses a series of differential characters not encountered hitherto in any anthropoid stock. This complex of characters exhibited is such that it cannot be interpreted as belonging to a form ancestral to any living anthropoid. For this reason, we may be equally confident that there can be no question here of a primitive anthropoid stock such as has been recovered from the Egyptian Fayum. Fossil anthropoids, varieties of Dryopithecus, have been retrieved in many parts of Europe, Northern Africa, and Northern India, but the present specimen, despite its youth, cannot be confused with anthropoids having the dryopithecid dentition. Other fossil anthropoids from the Siwalik hills in India (Miocene and Phocene) are known which, according to certain observers, may be ancestral to modern anthropoids and even to man

Whether our present fossil is to be correlated with the discoveries made in India is not yet apparent; that question can only be solved by a careful comparison of the permanent molar teeth from both localities. It is obvious, meanwhile, that it represents a fossil group distinctly advanced beyond living anthropoids in those two dominantly human characters of facial and dental recession on one hand, and improved quality of the brain on the other Unlike Pithecanthropus, it does not represent an ape-like man, a caricature of precocious hominid failure, but a creature well advanced beyond modern anthropoids in just those characters, facial and cerebral, which are to be anticipated in an extinct link between man and his simian ancestor. At the same time, it is equally evident that a creature with anthropoid brain capacity, and lacking the distinctive, localised temporal expansions which appear to be concomitant with and necessary to articulate man, is no true man. It is therefore logically regarded as a man-like ape. I propose tentatively, then, that a new family of *Homo-simiadæ* be created for the reception of the group of individuals which it represents, and that the first known species of the group be designated *Australopithecus africanus*, in commemoration, first, of the extreme southern and unexpected horizon of its discovery, and secondly, of the continent in which so many new and important discoveries connected with the early history of man have recently been made, thus vindicating the Darwinian claim that Africa would prove to be the cradle of mankind.

It will appear to many a remarkable fact that an ultra-simian and pre-human stock should be discovered, in the first place, at this extreme southern point in Africa, and, secondly, in Bechuanaland, for one does not associate with the present climatic conditions obtaining on the eastern fringe of the Kalahari desert an environment favourable to higher primate life. It is generally believed by geologists (*vide* A. W. Rogers, "Post-Cretaceous Climates of South Africa," *South African Journal of Science*, vol. xix., 1922) that the climate has fluctuated within exceedingly narrow limits in this country since Cretaceous times. We must therefore conclude that it was only the enhanced cerebral powers possessed by this group which made their existence possible in this untoward environment.

In anticipating the discovery of the true links between the apes and man in tropical countries, there has been a tendency to overlook the fact that, in the luxuriant forests of the tropical belts, Nature was supplying with profligate and lavish hand an easy and sluggish solution, by adaptive specialisation, of the

problem of existence in creatures so well equipped mentally as living anthropoids are. For the production of man a different apprenticeship was needed to sharpen the wits and quicken the higher manifestations of intellect—a more open veldt country where competition was keener between swiftness and stealth, and where adroitness of thinking and movement played a preponderating rôle in the preservation of the species. Darwin has said, "no country in the world abounds in a greater degree with dangerous beasts than Southern Africa," and, in my opinion, Southern Africa, by providing a vast open country with occasional wooded belts and a relative scarcity of water, together with a fierce and bitter mammalian competition, furnished a laboratory such as was essential to this penultimate phase of human evolution.

In Southern Africa, where climatic conditions appear to have fluctuated little since Cretaceous times, and where ample dolomitic formations have provided innumerable refuges during life, and burial-places after death, for our troglodytic forefathers, we may confidently anticipate many complementary discoveries concerning this period in our evolution.

In conclusion, I desire to place on record my indebtedness to Miss Salmons, Prof. Young, and Mr Campbell, without whose aid the discovery would not have been made; to Mr. Len Richardson for providing the photographs; to Dr Laing and my laboratory staff for their willing assistance; and particularly to Mr. H. Le Helloco, student demonstrator in the Anatomy Department, who has prepared the illustrations for this preliminary statement

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

6. S. P. LANGLEY (1831–1906)

LANGLEY'S invention of the bolometer, and his pioneer work in the construction of the flying machine, are achievements sufficiently great to ensure a reputation which will outweigh the recollection of defects due to an exaggerated consciousness of dignity, accompanied by a marked inability to see the humorous side of things. I first met Langley on the occasion of the total solar eclipse in August 1878, when he established an observing station on the top of Pike's Peak in order to obtain, if possible, a measure of the thermal radiation of the solar corona. Unfortunately, he suffered severely from mountain sickness, and had to be carried down before the day of the eclipse.

In the following year, Langley visited England and expressed to me the desire to become acquainted with Clerk Maxwell. I was working at the Cavendish Laboratory at the time, and was able to assure him that Maxwell would be interested to meet him as he had, in my presence, referred in very eulogistic terms to a method proposed by Langley to eliminate the personal equation in transit observations. Clerk Maxwell was just then editing Cavendish's scientific manuscripts, and conscientiously repeated every experiment that was described in them. He was specially interested in the method which Cavendish had devised for estimating the relative intensities of two electric currents, by sending the currents through his body and comparing the muscular contraction felt on interrupting the currents: "Every man his own galvanometer," as Maxwell expressed it. When Langley arrived, I took him to the room where Maxwell stood in his shirt sleeves with each hand in a basin filled with water through which the current was laid. Enthusiastic about the unexpected accuracy of the experiment, and assuming that every scientific man was equally interested, he tried to persuade Langley to take off his coat and have a try. This was too much for Langley's dignity; he did not even make an effort to conceal his anger, and on leaving the laboratory he turned round and said to me: "When an English man of science comes to the United States we do not treat him like that." I explained that, had he only had a little patience and entered into the spirit of Maxwell's experiment, the outcome of his visit would have been more satisfactory.

As an experimenter Langley takes a high rank, though the numerical results he derived were sometimes based on calculations that were not entirely free from defects. This led him occasionally to an optimistic judgment of their accuracy. In sending out an assistant to repeat his measurement of the so-called solar constant, which expresses the total solar radiation in certain units, his final words to him were: "Remember that the nearer your result approaches the number 3, the higher will be my opinion of the accuracy of your observations." The assistant, who since then has himself attained a high position among American men of science, fortunately was a man of independent judgment and skilful both in taking and reducing his observations, with the result that the number 3 is now altogether discredited.

[1] Continued from p. 163.

Obituary.

DR. J. M. ELLIS MCTAGGART.

THE news of the sudden death of Dr. McTaggart on January 18, at the early age of fifty-eight, came as a great shock to his numerous colleagues and friends both in Cambridge and throughout Great Britain. He had, indeed, resigned his lectureship in Trinity College, Cambridge, more than a year ago in order to devote more time to literary work; but he went on giving some of the courses of lectures he had been accustomed to give, and his interest in everything that pertained to the University continued to be as keen as ever. His Friday evening lectures, open to students of all schools, have been for many years past a Cambridge institution; and various stories are related of his acuteness, resource, and ready wit in endeavouring to initiate the *profanum vulgus* in the problems of metaphysics. In the affairs of his College and in those of the University he took a leading and conspicuous part, bringing to bear upon every issue a fearless independence of judgment, which won for him the

respect and esteem even of those to whom he was most opposed in opinion. In politics he was strongly conservative, although here again he never allowed himself to be fettered by party ties but pursued a path distinctly his own.

McTaggart was a born metaphysician Even as a promising and favourite pupil of J. M Wilson at Clifton, he is said to have displayed dialectical skill, and, on entering Trinity College, Cambridge, he began a brilliant career as an undergraduate, taking his degree as alone in the first class in the Moral Sciences Tripos of 1888 In 1891 he was elected a fellow of Trinity, having submitted as a dissertation the substance of what now forms the first four chapters of the book he published in 1896 (dedicated "to Miss Frances Power Cobbe, with much gratitude"), entitled "Studies in Hegelian Dialectic" There followed in 1901 "Studies in Hegelian Cosmology" An early draft of the last chapter on "The Further Determination of the Absolute" had been previously printed, in 1894, for "private circulation only", and in the preface to this pamphlet the author characteristically observed: "I hoped that an attempt to explain my position to a few of my teachers and fellow-students might produce criticisms or refutations which should be profitable either in improving or preventing any further work on my part" Still another book on Hegel -"A Commentary on Hegel's Logic"—appeared in 1910 Here we are told that Hegel had been the chief object of McTaggart's life for twenty-one years, and he expresses his conviction that Hegel had penetrated further into the true nature of reality than any philosopher either before or after him A more popular work, "Some Dogmas of Religion," saw the light in 1906, in it many novel views were propounded and they elicited no small amount of discussion Lastly, in 1921, McTaggart published the first volume of what was evidently intended to be his *magnum opus*, on "The Nature of Existence" It is understood that he has left the manuscript of the remaining volume in a condition that will enable it to be put into print, so that we shall fortunately not be deprived of the outcome of his maturest reflection.

To indicate the distinctive features of McTaggart's speculation in a few words is scarcely possible In the 'Commentary" mentioned above he stated his belief that the next task of philosophy will be to make a fresh investigation of the nature of reality "by a dialectic method substantially, though not entirely, the same as Hegel's", and, in his last book, he attempted to show how that task is to be fulfilled His method differs from Hegel's principally in neither accepting a *triadic* division of categories nor the partial falsehood of the lower categories. In the first part of his system, that dealing with the general nature of the existent, he admitted only two empirical premises—that "something exists" and that "what exists is differentiated"—and the rest, he claimed, is entirely *a priori*, in the second part, the results obtained in the first part were to be applied to the facts which empirical observation reveals, or appears to reveal.

McTaggart's idealism was not of the epistemological type, it did not rest, that is to say, upon any assumed dependence of the object known upon the knowing subject, it was what he was in the habit of calling ontological idealism, as based upon the ground that nothing exists but spirit. Spirituality he defined as the quality of having content, such content being the content of one or more selves; and he held that the only existent realities are selves, groups of selves, and parts of selves. Among these selves there might conceivably be one self whose volitions had the appearance of influencing the rest of the universe so profoundly that he would properly be called a god; but McTaggart could find no evidence which would make his existence probable. Indeed, if the universe consist of a system of selves, and if that system be a unity which possesses spiritual significance and value, there would be, he urged, no need of a directing mind to account for the traces of order in it In any case, if the universe be a society of selves, it cannot *be* a self; and, therefore, the *Absolute* cannot be God. Time, according to McTaggart, is an appearance which will ultimately merge into the timeless or the eternal Finite selves will go on existing after death until they reach the end of the time series They cannot be said to be immortal in the ordinary sense, but their lives will not really end, although their unendingness cannot be an unending duration in time.

G DAWES HICKS

MR. C. H. WORDINGHAM

MR CHARLES HENRY WORDINGHAM, who died on January 28 at the age of fifty-eight years, was well known as an electrical engineer He was born at Twickenham in 1866, and was educated at King's College School and at King's College, London. He served his apprenticeship under Dr John Hopkinson. He then joined the United Telephone Company, where his work consisted mainly in assisting with the erection of telephone exchanges. From 1889 to 1892 he was an engineer at the Grosvenor Gallery Generating Station of the London Electric Supply Corporation, where he was associated with Dr. Ferranti and Mr Partridge in carrying out many of the pioneering experiments which led the way to such important developments. During this period also he was head of the meter testing department and devised methods of testing switches and fuses which were very useful in practical work. In 1892 he again became an assistant to Dr. Hopkinson and supervised the erection of the electric lighting stations at Manchester and Whitehaven In 1894 he became chief engineer to the electricity works of the Manchester Corporation, and for the next seven years devoted himself whole-heartedly to developing the station.

In these early days many installations were laid down most carelessly, and the material employed was unsuitable. Wordingham established a testing department at the works and insisted that all the switches, fuses and other material used by his consumers should pass a standard test. He encountered great opposition at the start, but ultimately the manufacturers saw that it was to their advantage to have their devices tested. During his stay in Manchester he superintended the conversion of some 100 miles of tramways from horse to electric traction, and equipped 38 miles of new tramway.

Wordingham left Manchester in 1901 to practise as a

consulting engineer, and in 1903 he was offered and accepted the post of electrical engineer-in-chief to the Admiralty. Here he was responsible for the electrical equipment of all his Majesty's ships and for the electrical lighting and power used in the dockyards, including Rosyth and all the naval air stations. In 1918 he left the Navy and resumed his consulting practice. He was consulted by many local authorities on traction and lighting projects. He also gave expert evidence and supervised the erection of several power stations.

Wordingham served for many years on the council of the Institution of Electrical Engineers and no one took a greater interest in practically all the committees. He was president of the Institution in 1917 and 1918, and laid down a standard of work which subsequent presidents have found it difficult to equal He was very enthusiastic that the Institution should found a Proving House for all electrical apparatus and material, but many difficulties stood in the way. During his presidentship he helped to found the Society of Radiographers, which is doing useful work. He made many contributions to the technical journals and wrote a useful book on "Central Electrical Stations"

He was president of the Junior Institution of Engineers and always took the greatest interest in young engineers, doing his utmost to encourage them

A vast amount of work was also done by Wordingham in connexion with the Engineering Standards Association, being chairman of the Electrical Sectional Committees He also took endless pains in getting the Wiring Rules of the Institution of Electrical Engineers accepted by the authorities. He has died at a comparatively early age, leaving many of the projects in which he was enthusiastically interested half finished He was very popular with his colleagues, and he will be grievously missed by every electrical engineer

A R

Mr George Abbott.

Geology perhaps more than any other science needs all the assistance which careful amateurs can bring to the total sum of knowledge. Men living on the spot are of the greatest service to the official geologists when a re-survey takes place. George Abbott was one of the most painstaking of local geologists, whose help was always at the service of those who needed it. Born on March 25, 1844, he was in his eighty-first year when he died on January 12 at Tunbridge Wells, where he had lived since 1878 Scattered in various publications are many of his contributions to geology, but he was particularly interested in the various rock-forms which so often resemble organised life. From the magnesian limestone of Fulwell he obtained most of his specimens, and these he classified in so clear a manner that one was able to realise from his tables the series of stages by which such forms gradually grew to their familiar pseudo-organic shapes

In 1896, in conjunction with the Rev T R. R. Stebbing, Abbott conceived the happy thought of creating a union of scientific and similar societies in the south-east of England for mutual help, and the first two of the South-Eastern Union's Annual Congresses were held at Tunbridge Wells. The Union grew into a vigorous organisation and has held its annual congresses regularly ever since, whilst its annual proceedings, *The South-Eastern Naturalist*, is now accepted as a responsible scientific publication Some years later he founded a Geological Physics Society, but here apparently was a society which was not needed, for after a few years of vicissitude it ceased to exist. Its work is being done by other organisations, but as a protest against the overpowering study of palæontology it performed some useful work.

Abbott had suffered a good deal during the last few years, and his favourite study, apart from his medical duties, was a great comfort in the time that he was laid by He founded the local natural history society, and supplied many specimens to the elementary schools of the borough, on the Town Council of which he served for some years He also established the Eye and Ear Hospital at Tunbridge Wells, and was Hon. Surgeon from 1878 to 1886

We regret to announce the following deaths

Prof W A Haswell, F R S., emeritus professor of biology in the University of Sydney, and author, with the late Prof T. Jeffrey Parker, of "A Text Book of Zoology," aged seventy

Dr N Kulchitsky, lecturer in histology at University College, London, and formerly professor of anatomy in the University of Kharkov, on January 29

Dr. D B Spooner, deputy director of archæology in India since 1919, on January 30

Prof Hermann Schunck, a former director of the Badische Anilin- und Soda-Fabrik at Ludwigshafen, who retired in 1923, on January 8, at Solln near Munich

Current Topics and Events.

Elsewhere in this issue appears an account of a remarkable discovery which appears to afford *prima facie* evidence of the occurrence at a remote period in South Africa of a pre-human stock, neither chimpanzee nor gorilla, and possessing a series of characters differentiating it from any anthropoid hitherto known. Fossilised fragments from a limestone cliff formation at Taungs, 80 miles north of Kimberley, in Bechuanaland, when fitted together, have revealed a natural endocranial cast with almost the entire face of what at first sight appeared to be an anthropoid, but on closer examination is found by Prof. Dart to exhibit humanoid rather than anthropoid characters. The occurrence of a fossil anthropoid so far south would in itself be sufficiently remarkable, but the interest and importance of this discovery is enhanced by its remarkable divergence from the anthropoid and its approximation to the human stock. Not only is this exhibited in the character of the cranium as a whole, but it is also apparent in the formation of the brain, so far as this is indicated by the endocranial cast. The position of the foramen magnum, if correctly estimated, in itself would indicate that this sub-human type was well on the way towards acquiring the upright posture, and the inference of an increase in intelligence which would follow upon a

freer use of the fore-limbs is supported by the development of the association areas of the brain, which is such as to indicate a marked advance in the growth of intellect. So far are we taken by Prof Dart's preliminary report and the photographs which accompany it A detailed examination of the evidence upon which his conclusions are based must await the publication of the monograph now in course of preparation. Within recent years, South Africa, in the discovery of the Boskop and Rhodesian skulls, has added remarkable chapters to the history of early man; but even the interest of Rhodesian man may well be eclipsed if the claim of *Australopithecus africanus* be substantiated. In this event, we shall have advanced one stage further, and that a stage of the greatest importance, in the quest for the cradle of mankind, whether that eventually prove to have been in Africa or elsewhere

THE series of extracts from Dr Birch's "History of the Royal Society," that have been appearing in NATURE week by week during the past year, reached a conclusion with the article published last week. But to Lancelot, Lancelot succeeds, "Early Science at the Royal Society" will be followed by "Early Science at Oxford," a somewhat similar series of extracts taken from the Minute Books of the Philosophical Society at Oxford between the years 1683 and 1690 By some the Oxford Society is regarded as the origin from which the Royal Society sprang. Certainly it was a fully organised body, with a constitution and officers, more than ten years before the London Society received its first charter, or recorded proceedings; and even in the papers of the Royal Society itself there are occasional early references to "an ingenious assembly" meeting in Oxford. The gatherings were, however, somewhat irregular owing to the fact that the members having no proper meeting-house, had to rely upon private hospitality, which made it difficult for them to accumulate books or collections, or even to arrange experiments The building of the Ashmolean Museum, with a chemical laboratory in the basement and a room for the study of natural history on the first floor, provided the accommodation that was necessary for further progress, and on October 26, 1683, "The Company meeting in ye Naturall History School, desired Dr Wallis, to take on him ye trouble of ye Chair, and appointed Mr Musgrave to take ye Minutes of their Discourse." Extracts from Mr. Musgrave's minutes are now published for the first time

ON December 15 last the Foreign Secretary, in response to a question in the House of Commons asked by Mr A A. Somerville, M P. for Windsor, issued a Return giving full particulars of the Boxer Indemnity (Hansard's Debates, Dec. 25, 1924, p. 641, price 6d; or Christian Industrial Fellowship, 4 The Sanctuary, Westminster, price 1d.). The Return enumerates not only the Powers concerned and the annual quotas paid to each, but also, in the case of remitting Powers other than Great Britain, the operative instrument and the stated purposes of remission, together with the machinery set up. One notable point of this illuminating document is that all the other remitting Powers (United States, Japan, Russia, France) have defined the purposes of their remission by statute or other legislative process, leaving to committees the task of carrying into operation the purposes thus defined Another point common to all, except France, is that the purposes of remission are declared to be exclusively educational or cultural. even France makes a similar declaration, but its action is postponed until the debts of a state-guaranteed bank have been discharged. The remitted quotas—all of which continue until 1945—vary from 1,000,000*l* a year (Russia) to 150,000*l*. (United States), that being all that remains of her original share of 260,000*l* To Britain is due 400,000*l*. a year The German and the Austro-Hungarian quotas, 700,000*l*. and 30,000*l* respectively, were cancelled by the allies as a result of the War The China Indemnity Bill is down for second reading in the House of Commons on February 13 The Government will, it is understood, introduce the late Government's Bill, as amended in committee If, when the Bill becomes an Act, the present meaningless description of purposes is retained, an advisory committee, and not Parliament, will determine whether "educational or other" purposes shall, for example, be interpreted to include railways. It is hoped, however, that the Government may be induced so to define the purposes as to exclude this possibility, for though such a use of part of the fund might benefit a few contractors and employ a few engineers in China, it would certainly lower our prestige and alienate those for whom our remission of a just debt has been made.

PROF W J. DAKIN'S inaugural address on "The Teaching of Biology in Secondary Schools," delivered before the Liverpool Biological Society and published in vol xxxviii., 1924, of the Society's Transactions, is a forcible pleading for the inclusion of biology as a subject of general education in school curricula Not botany alone, or zoology alone; but the study of life-processes as manifested both in plants and in animals, the mutual relations of the members of the two kingdoms, and the bearings of both on human welfare—this is the type of biology that he advocates. Since in many schools botany is already taught, a large portion of the address is devoted to showing how zoology may, with a little foresight and slight expense, be likewise included in the teaching scheme. Difficulties that are feared, and objections that have been raised by some teachers, are discussed; and useful suggestions are offered by which apparent obstacles may be surmounted. An emphatic denial is given to the statement made in the Report of the Investigators of the Secondary School Examinations Council that "the principles of Biological Science can be better illustrated by means of botany, especially as physiology occupies a far more important part in the subject than in zoology, which does not readily lend itself to experimental treatment." There will doubtless be differences of opinion among teachers regarding the exact stage at which biology, in the full sense recommended by Prof. Dakins, can most

advantageously be introduced into the school time-table; but it is to be hoped that this address will be taken to heart and widely applied in those classes to which such teaching is appropriate.

DR. W. P. DAVEY, the research physicist of the General Electric Company of America, has produced a crystallised form of copper the electric conductivity of which is 13 per cent better than that of ordinary pure electrolytic copper. Prof. Bridgman, of Harvard, was the first to discover that copper could be produced in relatively large crystals by the method of slowly heating it in an electric furnace and then cooling it equally slowly. On December 31, Dr. Davey described to the American Physical Society his success in producing copper crystals nearly an inch in diameter and six inches long. These specimens could be bent without effort, but once bent they could not be straightened again This is attributed to the effect produced by the bending in upsetting the balance of the atoms of copper The crystals seem to readjust themselves into small crystals again, so that for all practical purposes it becomes a bar of ordinary copper and is equally inflexible. By X-ray examination it was shown that the prepared copper was simply one large crystal, the atoms being arranged in regular rows from end to end. When the crystal was hammered it lost its super-conductivity. The new copper has a greater conductivity than silver. At present its manufacture on a commercial scale is not feasible, but Dr. Davey thinks that the time is in sight when it can be used for ordinary dynamos and conducting mains As less copper would be required for a given service, it would cheapen the cost of conduits in underground work and of the towers required for overhead conductors.

SCIENTIFIC addresses by Sir Robert Hadfield are usually of a most comprehensive and enlightening kind, and that delivered by him before the Oxford University Junior Scientific Club on January 21 will delight all who see it in its published form. The address was entitled "Metallurgy and its Influence on Modern Progress," and it occupies about 190 pages, of which only a portion was read and illustrated by lantern slides and moving pictures Amongst the plates in the published volume is a particularly interesting one showing Roger Bacon (1214–1292), one of the early founders of scientific thought in Oxford; the illustration represents Bacon, who wrote letters "of the Secrets of Arts and Nature" to the Paris University, presenting a book to the Chancellor of that University. By kind permission of the War Office and Admiralty, Sir Robert was able to show, in the course of his address, a cinematograph picture, taken by himself and his staff, of loading and firing a 15-inch gun at the Government Proving Ground at Shoeburyness, including a view of the butt one sixteenth of a second later showing the impact on the plate; one half second later showing large numbers of fragments flying from the plate and the butt, and finally the unbroken projectile, weighing nearly one ton, after it had perforated the thick, hard-faced armour plate against which it was fired. The sections devoted to metallurgy in the book cover about one hundred pages, in which Sir Robert refers to the importance of iron in antiquity, and the rise and importance of alloy steels He gives a history of the invention by himself of manganese steel, silicon steel, and other alloy steels, and refers also to the value of heat treatment and the history of the pyrometer In concluding his address Sir Robert directed attention to the importance of effort, progress and international co-operation, and suggested that there should be an annual Science Day to impress upon the community the place of science in modern life.

SIR OLIVER LODGE'S third talk on "Ether and Reality," delivered on February 3 under the auspices of the British Broadcasting Co from the London Station, 2LO, was devoted to the electric charge and the means by which electric charges act on each other. The following are extracts from his instructive address.—Discoveries of the present century have shown (what had already been suspected by Faraday and Maxwell in the last century) that electric charges are discontinuous, like matter, that they exist as separate particles, although their field or region of influence extends throughout space. Moreover, electric particles or corpuscles are of two opposite kinds, which attract each other, and when very close together blot out each other's field at a distance and form a neutral combination Particles which attract each other need not fall into each other, any more than the planets fall into the sun The negative corpuscles can revolve round the positive, and thereby constitute a neutral group, with which we are familiar as an atom of matter. That is what an atom of matter is, that is what is meant by saying that matter is electrically constituted The particles of opposite sign are called electrons and protons and are joined by lines of force, which represent something going on in the ether, all electrical phenomena can be expressed in terms of these lines of force Lines of force represent a state of the connecting medium which unites electrons and protons and causes their apparent attraction Similar lines account for cohesion. Gravitational lines of force unite earth and moon We should always look for a medium, and we always find the ether operative in the physical universe; whether it is active in the mental universe we are not so sure Mind usually acts on mind through a physiological mechanism, whether such indirect mode of connexion is always necessary is a subject for investigation. The laws of mental action may be quite different from physical laws, we should not let mechanism dominate us, for we may have to enlarge our conceptions.

"THE Mountain Structure and Geographical Relations of South-eastern Asia" formed the subject of a discourse delivered at the Royal Institution on Friday, January 30, by Prof John W. Gregory. Prof. Gregory stated that the continuity of the Alpine-Himalayan system has been proved from western Europe to eastern India. Its further eastward continuation, according to one view, is across central China to Bering Straits, and according to another through western Burma to Sumatra and thence along

the southern islands of the Eastern Archipelago. Its diversion from its eastward course has been attributed to the mass of Chinese Tibet, the structure of which is complex, being due to movements at two different dates. The later movements belong to the series which made the Alps and Himalaya and are geologically modern The other group is much older and is represented in Asia by the Altaid mountains. The most direct proof of the Himalayan movements is afforded where rocks which, as in the salt basin of Yunnan, were not in existence when the Altaid mountains were made have been intensely folded. At the end of the Altaid uplifts, the site of the Indian Ocean was covered by Gondwanaland, which extended from South America across the Old World to Australia This continent was broken up by successive subsidences, and the gulfs thus formed gradually became the Atlantic and Indian Oceans These movements were accompanied by volcanic eruptions, which deluged equatorial Africa and western India under floods of lava, while East Africa was torn asunder by the formation of the Great Rift Valley One difficulty in the explanation of these eruptions and fractures by the foundering of the floor of the Indian Ocean was the apparent absence of any corresponding phenomena on its eastern side The evidence now shows that Burma and western China were disturbed by volcanic eruptions and fractures contemporary with those of East Africa The geographical relations of the mountains of south-eastern Asia therefore indicate that the Alpine-Himalayan system is part of a belt of crumpling of the crust where the in-sinking northern dome of the world pressed against the tropical and subtropical belt

AT a meeting of the Newcomen Society held on January 28 two historical papers were read, the first being by Mr Hamilton, an American member, on "The Windmills of Cape Cod," while the second was by Mr. David Brownlie, and was entitled "Some Notes on a Neglected Worthy, John Patison of Airdrie" John James Patison was born at Leith in April 1828 and died at Inverkeithing in July 1905. Though his youth was passed in a bookshop and a bank in Edinburgh, he was able to start a salt works at Musselburgh, and afterwards, when he had removed to Airdrie, he began experimenting on the carbonisation of shale, and near Airdrie he established the Whiterigg Chemical Works Mr Brownlie referred to him as one of the earliest practical workers in the commercial development of the Scotch shale oil industry, though its real founder was, of course, James Young The distillation of shale at Whiterigg ceased about 1864, a few years after the discovery of American petroleum Patison was also the inventor of an internal screw conveyer retort, and Mr Brownlie in his paper gives some interesting details of other inventors in the same field.

THE rainfall of 1924 is dealt with in the *Meteorological Magazine* for January, but at present it is only possible to outline the general features. Over the British Isles as a whole, the year was unusually wet; the average fall was 48·5 in., which is 117 per cent. of the normal. It was wetter than any year since 1903, when the rainfall over the British Isles was 52·5 in. or 127 per cent. of the normal. In 1924 the rainfall was only slightly heavier than in 1916 and 1912, when the percentage of the average was 115 and 116 respectively. In parts of Scotland and the north of England, there were fairly large areas where the 1924 rainfall was deficient, and at Louth in Lincolnshire the rain was only 89 per cent. of the average. In England and Wales the rainfall for the year was 121 per cent. of the average for the 35 years, 1881–1915, in Scotland it was 105 per cent., and in Ireland 122 per cent. More than 140 per cent. of the average occurred on Dartmoor, on the Cotswolds, and to the north of London at Maidenhead and Chelmsford At High Wycombe, in Buckinghamshire, rain measured 38·94 in, which is 13·04 in. more than the average, and is 50 per cent. above the normal; it is the largest fall, with the exception of that in 1903, since records were commenced in 1846 The London rainfall, according to the Camden Square records, was 33·08 in, which is 8·61 in or 35 per cent above the normal, the largest rainfall since 1916 Rain fell in London on 188 days, and the duration of rain for the year was 539 6 hours January, May, September, and December were all very wet, whilst February and March were unusually dry.

THE Hunterian oration in connexion with the Royal College of Surgeons of England will be delivered at the college on Saturday, February 14, at 4 o'clock, by Sir D'Arcy Power.

SIR WILLIAM B HARDY will deliver a lecture on "Problems presented by Films on Solid Surfaces," under the auspices of the Chemical Society, at 8 P.M. on Thursday, February 26, in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S W. Invitation has been extended to fellows of the Physical Society.

ON Tuesday, February 10, at 5 15 P M, Prof. J. Barcroft, Fullerian professor of physiology, begins a course of four lectures at the Royal Institution on the colour of the animal creation. The Friday evening discourse on February 13 will be delivered by Dr. B. Malinowski on the forces of law and order in a primitive community, and on February 20 by Prof T H. Pear on acquiring muscular skill

THE Minister of Agriculture and Fisheries has appointed a permanent committee to advise the Ministry on all questions relating to agricultural meteorology. The committee consists of:—Sir Napier Shaw (Chairman), Prof. V. H. Blackman, Mr H. Corless, Mr. R A Fisher, Mr. J. C. F. Frver, Mr. R. H. Hooker, Mr. R. G. K Lempfert, Sir Thomas Middleton, Mr. J. Ramsay, Mr. H G. Richardson; Mr. W. R. Black, of the Ministry of Agriculture, has been appointed secretary of the committee.

AT the annual council meeting of the National Union of Scientific Workers, which was held at the University of London Club on January 31, the president, Prof. G. H. Hardy, announced that the efforts which the Union has been making for some

time past to obtain an increase in the Treasury grant to the Royal Society, in aid of scientific publications, have been successful. It is understood that, in the estimates for the coming financial year, the Government will make provision for an increase in this grant from 1000*l.* to 2500*l.* a year. The Annual Report of the Executive Committee records many other activities of the Union which are of interest and benefit, not only to members, but also to the scientific world at large. During the past year, three new branches have been formed, and the number of new members elected has been considerably larger than in previous years.

LAST month Mr A Cobham made a flight over the Himalayas The *Times* gives some details of his journey. Leaving Calcutta he reached Jalpaiguri in 3½ hours, the object of this part of the journey being to survey an air route to Darjeeling. From Jalpaiguri he started his reconnaissance over the Himalayas, passing over Darjeeling at a height of some 9000 ft Flying towards Kinchinjunga, Mr. Cobham experienced difficulties at about 12,000 ft., but after turning and descending, he returned and climbed without difficulty to 17,000 ft. At that altitude breathing was not easy, but temperature was not so low as at 12,000 ft After taking a series of photographs of the range, Mr. Cobham returned to Jalpaiguri, having occupied only 3½ hours in his flight He believes that the whole Himalayan range could be accurately surveyed from the air at a relatively small cost, and that a flight over Mount Everest would be easy

THE arrears due to the War in the great *Index Kewensis* are being rapidly overtaken. The last pre-War Supplement, covering the years 1906–10, was published in 1913, and it was not until nine years later that it was possible to issue Supplement V., covering the years 1911–15. But Supplement VI., covering the years 1916–20, is now complete, and printing has begun at the Oxford University Press We learn from the publishers that their stock shows that a large number of sets of the work have not yet been completed to date by the addition of Supplement V. (published in 1921), and they ask us to direct the attention of librarians to this fact. The value of the work, both scientific and pecuniary, is, of course, seriously impaired by the failure to complete sets; and the relatively low price at which the Supplements are issued has been made possible by the support given by librarians and learned institutions all over the world.

INTERMITTENT bournes are flowing in chalk areas in the south-east of England, and the Croydon bourne is no exception. It is probably not yet at its highest, but broke out as usual in the garden of the Rose and Crown, at Warlingham It is now gradually creeping up the valley. More interesting is the fact that the Addington-Wickham Bourne is again out This, after disappearing for about 33 years as a flow of any magnitude, appeared in June 1916, and is now again flowing, but it has passed its maximum The gravel-pit which has been made in its path was covered by water, but not to any depth, and it is subsiding. This bourne is not directly on the chalk, but wells up through a thickness of tertiaries, and hence does not appear until these have been saturated It is noteworthy as being in the valley which must have been at one time an upper reach of the Ravensbourne. Sodden patches which have been let down near its source seem to show that underground solution is taking place to some extent

Our Astronomical Column.

THE OPPOSITION OF EROS IN 1931.—This opposition will be much the most favourable since Eros was discovered in 1898. Dr. Witt, who discovered the planet, has been engaged on the study of its perturbations up to 1931, and announces that he has now completed this work. The German observatories are now making arrangements for the careful observation of stars that lie near the planet's track, as they will be required as reference stars; they are also inviting co-operation in other countries.

The details of Dr. Witt's work are not yet published, but the following ephemeris, based on earlier elements, gives a general idea of the conditions during the time that the planet is within 19 million miles of the earth.

		R.A.	Decl.	log Δ.
1931.	Jan. 5	10h 17m	25° 16′ N.	9·306
	,, 13	10 19	17 32	9·264
	,, 21	10 16	8 45 N.	9·236
	,, 29	10 8	0 24 S.	9·226
	Feb. 6	9 56	8 44	9·238
	,, 14	9 45	15 31	9·265
	,, 22	9 35	20 10 S.	9·307

The maximum parallax, on Jan. 29, is about 52″.

Longer preparation is possible on this occasion than at the 1901 approach, and the minimum distance is little more than half so great; thus we may hope for a corresponding increase in accuracy

THE U.S.A. NAVAL OBSERVATORY, WASHINGTON.—The report of the superintendent, Capt E T Pollock, for the year ended June 30, 1924, has been published. In the Nautical Almanac Department, special investigations have been made of the orbits of the satellites of Saturn and Neptune. In the latter 1633 observations, ranging from 1889 to 1923, are included. A new catalogue of 1504 standard stars has been constructed and half of it is in type The positions of the stars are a decided improvement on those in Boss's General Catalogue. Most of the Nautical Almanac for 1927 is in type

The details are given of work with two transit circles and several equatorials, with these last, satellites and minor planets were observed. There were two dates when the sunspot activity showed a minimum, February 1923 and the end of August 1923. Numerous observations were made with the Prime Vertical Instrument: three determinations of the constant of aberration from these observations are 20·54″, 20·55″, 20 58″. All appear to be on the large side.

The Department for Training Naval Officers includes branches for studying the gyro-compass and the magnetic compass.

Research Items.

PRIMITIVE MURAL DECORATION IN SOUTHERN INDIA.—A paper by the late Dr Nelson Annandale, published in vol viii No. 4 of the Memoirs of the Asiatic Society of Bengal, describes a primitive but effective form of art which is found in a Uriya village on Samal Island on the northern shore of Lake Chilka in Orissa The people of Samal speak the Uriya language, but physically they are a mixed type, some showing traces of aboriginal blood while others present a Mongoloid appearance Their culture is primitive and nominally they are Vishnuvite Hindus mostly of the Goala or cowherd caste Some of the houses are composite, sheltering several families under one roof The walls of the houses are uniformly covered with a wash of red earth forming the background of the decorations The simplest form of pattern is made by applying the three fingers dipped in chalk and water to the walls The more elaborate patterns fall into two groups, of which the character is indicated by their names One is called *janar*, a kind of maize, the other *punjha pareda*, "four coconuts," of which, however, only three can be distinguished as a rule. These patterns are usually executed by men More elaborate designs also are in use, some made by women, in which birds and fishes appear Most of the interior decorations were painted in several colours, while some of those used in internal passages were mythological Outside are certain lucky signs, such as double fish and footprints; the object of the decorations seems to be purely æsthetic.

ARCHÆOLOGICAL REMAINS IN NEW ZEALAND.—In vol ii No 4 of the Records of the Canterbury Museum, Mr H. D. Skinner continues his description of the objects found in caves near Christchurch, N Z., opened in 1889, which were sent to the Otago University Museum in 1922 The material from Monck's Cave, which is situated about a mile east of the Moa-bone Point Cave previously described, although more interesting than that found in the latter, is scientifically of less value, as no record was kept of its stratification. Sixteen pieces of moa bone were sent to the Museum, eight of which were worked. One of the most interesting articles found was a carved bailer, the only known example from South Island, which, with a paddle, was found immediately the cave was opened. It is therefore probably of later date than the moa-hunter age Its decorative *motif* of a bird's head and loop coils was not previously known from this district. An outrigger float is the only New Zealand example which has been preserved Of a number of adzes, several were Polynesian in form but none of West Pacific types. Among a variety of other articles were a toy canoe and paddle and a toy dog, which confirms the accounts of Maori dogs given by early travellers. One of the most interesting discoveries was a series of cuttings of human hair showing a considerable variation in pigmentation, ranging from dark brown to chestnut. Its very fine plaiting points to Polynesian relationship.

COLOUR FATIGUE IN THE EYE.—In a pamphlet (reprinted from *The Medical World*) Dr. F. W. Edridge-Green, who is special examiner and adviser to the Board of Trade on colour vision and eyesight, quotes the following passage from Dr. Troland on minuthesis (that is, colour fatigue): "The general conclusion to be drawn from the work is, therefore, that minuthesis due to one colour does not alter the luminosity of another colour to a degree differing appreciably from that in which it is altered itself. In other words, the change in sensitivity to brightness occasioned by stimulation of the retina is independent of the wave-length constitutions of the minuthetic and of the reacting lights. This seems to imply that the luminosity function is not essentially linked with the colour or chromatic function, and stands in contradiction to the views of Abney, Ives, and others, who treat luminosity as the sum of the primary colour values of any stimulus. The present results appear also to be in conflict with experimental data along similar lines published by Abney and by Burch, so that further study of the problem would seem to be required on a larger number of subjects." These conclusions are in agreement with those to which Dr. Edridge-Green himself and co-workers have come (see "Physiology of Vision," p 248, Proc. Roy. Soc., 1912).

LARVÆ OF DECAPOD CRUSTACEA.—Notwithstanding the strange forms they frequently assume, the larvæ of decapod Crustacea have in recent years received very little attention at the hands of zoologists. This is no doubt due to the great labour involved in linking up unknown forms with parents which often have a widely different appearance, and to a fear that, when all is done, little real advance will have been made in our knowledge of the group In his report on the larval decapods obtained by the British Antarctic (*Terra Nova*) Expedition (Crustacea, Part IX. British Museum (Natural History) 1924 Price 15s.) Mr Robert Gurney has shown that such studies may yield indications of great phylogenetic importance. Although the numbers of known larvæ are still few in comparison with adults, it is clear from Mr Gurney's work that a classification derived from them will sometimes diverge in a striking manner from the system generally adopted. This system, based mainly on the morphology of the adult decapod, is none too securely founded, and there is little doubt that a knowledge of the larval structure will be of great assistance in its revision Two of the more important conclusions that Mr. Gurney has reached are that the Stenopidea should be removed to the Reptantia, and that the Thalassinidea are not homogeneous, but fall into two divisions—a Homarine series, including the Axiidæ and Callianassinæ, and an Anomuran series, including the Laomediidæ and Upogebiinæ A feature that will appeal strongly to every student of the group is that in Mr Gurney's work he is provided, for the first time, with a systematic presentation of all available information on decapod larvæ Under most of the family headings the principal larval characteristics are summarised or discussed, and there is a valuable list of references to the widely scattered literature

THE TANNING QUALITIES OF MANGROVES.—In *Indian Forest Records*, vol. x. part x for 1924, Mr. J. A Pilgrim has an interesting account of the mangroves of Tenasserim as a possible source of supplies of tannin. The writer was appointed tannin expert to the Government of India with the idea of surveying from this point of view the mangroves of Burma, but as delay was caused in this project through the War, he has in the meanwhile carried out an investigation of the mangroves of the Sundarbans of Bengal, and thus is able to compare his Burmese results with further data obtained in more northern latitudes. Pilgrim points out that whilst on the whole the mangroves of the Sundarbans and of Tenasserim show no noteworthy differences, yet on the whole, (1) the best of all the mangrove tans, and (2) the commonest of these tans, both show themselves richer in tannin in the more southern

latitude. The best source of tannin is said to be *Carapa moluccensis*, the commonest *Rhizophora mucronata*. This latter species has been widely collected, and Pilgrim points out that it has shown itself richer in Borneo than in the Philippines, whilst chemists in Sarawak, S. Borneo, get somewhat higher yields of tannin than Pilgrim from N Borneo, and now the Burma material proves more valuable than that from Bengal The writer concludes that his present results seem to support the general thesis that mangroves increase in tannin content as they approach the Equator.

OVERSEAS TRANSPORT OF APPLES.—Early in 1923 a scientific expedition, consisting of Dr Ezer Griffiths, Mr. A. J Smith, and Mr Edgar A. Griffiths, was sent by the Food Investigation Board to study problems involved in the transport of apples from Australia to England. Special Report No. 20 of the Board, entitled, "The Problems of Apple Transport Overseas," by Drs Kidd and West (H M S O, price 9*d* net), is a general survey and summary of the results obtained. The investigation originated in an inquiry as to whether the disease known as "brown heart" could be correlated with the atmospheric conditions in the holds in which the apples were carried Four boats, representative of the different systems of marine refrigeration in use, were studied and a complete record obtained of the carbon dioxide content of the atmosphere of the holds, and of the temperature distribution in the interior of the cargo of apples One surprising result observed was the magnitude of the accidental ventilation which takes place due to leakage; calculations based on the estimated rate of production of carbon dioxide by the respiration processes of the apples and the periodic measurement of the amount of gas present in the hold show that, in one of the boats studied, about 300 cubic feet of air per day per ton of apples finds its way into the hold. This was the case of a boat equipped with forced circulation of the cooled air In a boat depending on convection currents from cold brine pipes for the cooling effect, the leakage was considerably less and the accidental ventilation was only just sufficient to keep the carbon dioxide concentration below the danger limit of about 10 per cent. Another important result of the expedition was to show that none of the present systems employed for the stowage of the apple cases produced a uniform temperature distribution throughout the mass This is a problem which is now being studied at the National Physical Laboratory by the aid of scale models. The expedition also afforded an opportunity for observing under marine conditions the behaviour of various types of physical apparatus used in the investigation, such as electrical thermometers, carbon dioxide indicators, hygrometers, and anemometers

PETROLEUM IN THE LOST SOLDIER-FERRIS DISTRICT, WYOMING.—Messrs. A. E. Fath and G. F. Moulton, of the United States Geological Survey, have recently completed their work in this interesting area of south central Wyoming, an area in which there has been active oilfield development since 1916. The results of the survey are contained in Bulletin 756. The geology conforms with that characteristic of the Big Horn Basin as a whole, and, as would be expected, Cretaceous beds constitute the most important stratigraphical and economic formations. In this area of about 600 square miles, the authors have described nine domes and anticlinal folds with which oil and gas are associated; these local structures, regarded as being post-Oligocene in age, are superimposed on what is known as the Rawlins Uplift, a regional structure of early Tertiary or even older achievement. Some difficulty was experienced in mapping the district owing to the outcropping formations being much concealed by alluvial wash and blown sand, but two of the domes, Lost Soldier and Bunker Hill, are indicated topographically, especially the first, which accounts for its earlier development as an oilfield. Faulting has affected the structures considerably, most dislocations cutting across the flanks of the folds; this naturally has a marked influence on the distribution of the oil-sands involved. In 1921 the Lost Soldier field produced 380,811 barrels of oil from 28 wells, in the same year the Ferris Dome produced 16,740 barrels, and what is known as the "G.P. Dome" yielded 74,199 barrels from 3 wells On another, the Mahoney Dome, a rich gas sand was encountered with an open-flow yield estimated at 50,000,000 cubic feet of gas per day, lightning ignited the gas and the well burned for 27 days before being extinguished, which was accomplished by exploding a 25-pound charge of dynamite close to the well-mouth, taking advantage of the momentary slowing down of the gas flow and then snuffing with steam These and other significant facts indicate that the area has decided commercial possibilities, though accessibility and questions of transport and marketing of the oil are problems which apparently are only just being solved

WIND DIRECTION, CLOUD AND VISIBILITY.—The Meteorological Office, Air Ministry, in Professional Notes, Vol 3, No 36, gives a discussion "On the inter relation of wind direction with cloud amount and visibility at Cahirciveen, Co Kerry," by Mr. L. H. G. Dines and Mr P I Mulholland The object is to ascertain whether there is a statistical relation of sufficient magnitude to aid in forecasting the amount of cloud and visibility at night from observations in the afternoon and evening The data for cloud cover a period of ten years from 1911 to 1920 South winds are the most common, followed by south-west and west The outstanding feature is the excessive amount of cloud with south winds in each season and at different hours of the day The clearest skies occur with calms in spring and north-east winds in winter and autumn, a clear sky may be expected, with either, once in 5 or 6 times on the whole, as against once in 77 for south-west winds. For the inter-relation of wind direction and visibility the data employed are for about two years, 1919 and 1920 As a rule, visibility at Cahirciveen is good, the best occurring with northerly winds, the poorest with southerly, the latter being due to the generally damp conditions prevailing with such winds The authors deal with the Beaufort letter "v," *unusual visibility*, as a sign of coming rain, and so far as Valencia Observatory is concerned, observations there do not support the old theory. Much more proof than observations at this special observatory will be required substantially to disprove its general applicability As a standard for normal humidity, the observations for 1886–1910 are used, it must not be overlooked that a good many years ago the position of Valencia Observatory was shifted from an island to the mainland.

METAL CLAD ENCLOSURE OF CONDUCTORS.—The tendency of modern electrical engineering is to devise automatic operation to replace manual operation, and so provide "mistake-proof" plant. As the voltages of transmission, owing to the large amounts of power that have to be transported, are continually being raised, it is necessary also to devise methods of making contact with a "live" conductor a practical

impossibility. Mr. H. W. Clothier, in a paper read to the Institution of Electrical Engineers on January 22, gives a very able discussion of these and similar problems. He points out that the ideal arrangement is to enclose metallically every conductor so that it is completely inaccessible when alive These metallic covers are connected with the earth, and if they be used over the whole supply system from the generators to the load, they provide practical immunity from burns and shocks. If this method is carried to its logical conclusion, overhead lines would have to be replaced by underground cables. The initial cost, however, of high-tension underground cables is at present in most cases prohibitive, and so compromises have to be arranged It is also of importance that faults occurring in a transmission system should be rapidly cleared, as in several cases high-frequency currents are set up in the system, and these produce very serious electromagnetic interference with neighbouring telephone and telegraph lines Shocks and fires from this form of interference are an appreciable "risk," and have to be taken into account The author concludes that, for safety of the operators and continuity of the supply, the use of universal metal-clad enclosure is highly desirable There should always be a stable neutral point on the network maintained at earth potential, and all operating mechanisms should be thoroughly trustworthy and be periodically inspected.

THE POLYMORPHIC FORMS OF IRON.—The issue of December 5, 1924, of *Die Naturwissenschaften* contains an interesting summary by F Wever on the physics of the technical varieties of iron. The remarkable variation of properties of this material which makes it so valuable a substance depends essentially on the fact that iron can be obtained in several polymorphic forms, the behaviour of which towards carbon, which invariably accompanies such iron, is very different The author reviews the properties of the polymorphic forms of pure iron, of which there are four, namely, α, β, γ, δ. The lattice forms of α-, β-, and δ-irons are the same and are those of a body-centred cube, while that of γ-iron is a face-centred cube. The maximum solubility for carbon is possessed by γ-iron and corresponds to 1·8 per cent. at 1140° δ-iron, which only exists between 1535° and 1410°, can dissolve 0·38 of carbon at the latter temperature In contrast with this the solubility of carbon in β- and α-iron is extremely small The properties of iron carbide and the relations between iron and carbon are discussed in the latter part of the paper, which concludes with a brief summary of the theory of hardening. The author favours the theory of Maurer, according to which carbon is in a condition of atomic dispersion in α-iron, the volume of which is thereby decidedly increased The condition of strain thus induced is regarded as the cause of the exceptional hardness of such steel.

THE SILICA OF PLANTS.—D. R. Nanji and W. S. Shaw have recently found (*Chemistry and Industry* Trans., Jan 2) that about 90 per cent. of the total silica occurring in plants is present as free silicic acid, probably in the colloidal state The remaining 10 per cent. is in a form from which it can only be extracted after preliminary treatment with acid, probably as an ester-like combination with a polysaccharide constituent of the plant.

THE IDENTITY OF GEBER.—E. J. Holmyard, in an article on the present position of the Geber problem in *Science Progress* for January 1925, considers it definitely established that Geber is Jābir ibn Hayyān. The Latin works ascribed to Geber are probably not literal translations from the Arabic, but are works based on Arabic knowledge. There is not sufficient evidence at present definitely to state that these Latin works are genuine. A study of the works of Jābir confirms his reputation as the greatest chemist of Islam.

THE ULTRA-CENTRIFUGE.—Svedberg and Rinde, in the Journal of the American Chemical Society for December 1924, describe a new instrument, the ultra-centrifuge, for the determination of the size and the distribution of size of particles in amicroscopic colloids It enables particles which are invisible in the ultra-microscope to be measured. The theory of the instrument is given in detail; measurements of the radius of the particles of gold sols (average radius 2·3-11·6 $\mu\mu$) made with this instrument give values 11-38 per cent. higher than those obtained by Zsigmondy's nuclear method The nature of the protective action of gelatin upon fine-grained gold sols is also studied, minimum and maximum values for the thickness of the gelatin layer adsorbed around the gold particles being obtained.

CRYSTAL FORMATION.—The development and formation of crystals is the subject of a paper by Dr. T. V Barker in *Chemistry and Industry* for January 16. Among the topics discussed are lattice structure; polymorphism and isomorphism, mixed crystals; chemistry of the crystalline condition The main lines of advance in the X-ray examination of crystals are outlined. The section on crystal mixtures is somewhat detailed. The equilibrium relations between a mixed crystal and its mother liquor are most simply illustrated by leaving out of account the variable amount of water (or other solvent) requisite for solution, and then plotting percentage composition by weight of the two constituents of the mixed crystal against their relative proportions in the solution Two types can then be distinguished, the first of which is illustrated by mixtures of cobalt and ferrous sulphates, and the second by mixtures of potassium permanganate and perchlorate (Muthmann and Kuntze). The complete equilibrium diagram of ferrous and magnesium sulphate mixtures is given for the first time; the system belongs to the second type.

LOW TEMPERATURE TREATMENT OF BITUMINOUS MATERIALS.—T. W. S Hutchins, at a joint meeting of the Chemical Engineering Group and the London Section of the Society of Chemical Industry on January 16, gave an account of the low temperature treatment of bituminous materials. He set out by cataloguing the conditions which must necessarily be fulfilled if such a process is to be technically successful. It would seem that these conditions are extremely stringent, for the number of such "points" (in the Wilsonian sense) reached twenty-two. He described the development of the "fusion" retort and its construction as at present used It consists of a horizontal, revolving, externally heated retort through which the comminuted material passes. The retort contains a series of paddles on a free horizontal shaft, so that when the retort revolves, these paddles roll over in such a way as to churn up the charge, facilitating the escape of vapours and at the same time preventing the growth of accretions on the walls of the retort. It would seem that the plant is designed primarily for the recovery of liquid distillation products, and the yields obtained from a number of bituminous materials are given, but without data to indicate how far the processes are commercially successful.

Scientific Work of the Fishery Board for Scotland.[1]

AMONGST the points of scientific interest in the report for 1923 of the Fishery Board for Scotland are the facts pertaining to the continued abundance of all kinds of fishes, swarms of small haddocks especially being noted Thus the total capture was little short of that in 1919, though exceeded by that in 1920 when the rush of boats was at its height. Herrings show no sign of diminution even under the unfavourable conditions of capture, the returns much exceeding those of the previous year, and almost reaching those of 1913

The work of the scientific staff includes a paper of special interest by H. Thompson on "Problems in Haddock Biology," which has already been noticed in NATURE (August 30, p 333).

Alex. Bowman treats of Arnoglossus and especially of what he thinks a post-larval *A. imperialis* (with a coloured figure). He remarks that *A. laterna* has a similar distribution to the sole (*Solea vulgaris*), and asks what are the factors which have prevented its establishment on the East Coast of Scotland by Nature or by transplantation. The sole has always, however, occurred sparingly on the East Coast in such bays as St. Andrews, and the transplantation of about 600 from Scarborough to this bay has had little effect on its abundance. He points out that other species of Arnoglossus enter by the Strait of Dover and reach the Skager Rack and the Cattegat, whereas he thinks *A imperialis* must have reached the northern North Sea (where 3 young specimens were found) from the Atlantic, and that they do not survive. Possibly investigations both of the life-histories of the several species and of the various currents may afford further information. The efforts by the same author to locate the areas in which the herring spawn by the capture of what he terms "spawny" haddocks which "are well fed and plump of form, and have a characteristic bloom on the epiderm which masks the black pigment," seems to be somewhat far-fetched, for, whilst no less than 80 boxes of large haddocks may be caught where the herrings spawn, no more "bloom" occurs on those with their stomachs full of ova than on those caught by the liners on other grounds. Again the cod, which feeds on the ova of the herring no less greedily than the haddock and even scoops up quantities of gravel with this food, presents no external change. No doubt such investigations are useful on unknown ground—though the external changes are more or less imaginary.

In a careful contribution on the use of the Petersen grab, A. C. Stephen perhaps makes too much of this instrument, which, though a useful adjunct to other methods of ascertaining the fauna of the sea-bottom, such as the dredge and the trawl, falls far short of the revelation a single storm will disclose on the beach. Not all the elaborate calculations of this and that species per square yard brought up by the grab will add more to our knowledge than the storm. It is curious that neither Pecten nor Nephrops (the rich food of the cod) seems to have come in the way of this instrument in the area of the Firth of Forth.

An interesting digest of the summer herring fishery of 1922 is made by H. Wood, whose observations and the accompanying map point to the occurrence of shoals in the same areas from June to September, the shoals perhaps differing in their composition, but still affording good catches He found that the northern large herrings spawned before the southern, and he makes remarks on the spawning areas and the times of spawning, an intensive period being the end of August.

An elaborate and interesting paper is that by Prof. D'Arcy Thompson on the trawling statistics of Aberdeen from 1917 to 1921, in continuation of that issued in 1917, the period comprising two of the War years and three of unusual activity These statistics again emphasise the fact that the old East Coast fishing grounds are as productive as formerly, the value of the catches being more than doubled, and this in face of the usual pessimistic views of the sea-fisheries. Whilst the post-War catches were much above the average, it is noteworthy that in 1917 the captures of codlings rose considerably, indeed were greater than in any previous year, and continued at a high level until 1920 Cod were much in the same condition. Haddocks, which had been rather scarce in 1914 and 1915, went beyond pre-War levels in 1916 and continued to increase until 1919, the average per voyage being nearly four times that of 1913, and, though diminished in 1920 and 1921, were still above pre-War catches. The advocates for accumulation during the War would point to this as proof of their theory, but such irregularities have often occurred previously and will occur in the future

An important addition to the scientific equipment of the Fishery Board is the new Research Laboratory, a brick building of one story, with various rooms for the staff, besides a museum and library. It is within easy reach of the Bay of Nigg and Torry Harbour, Aberdeen. The Fishery Board apparently at present assumes responsibility for these researches, which do it credit, but perhaps in future it would be well if, as in the case of the Royal Society, the caution were prefixed that the Board does not accept responsibility for the views of the authors W. C. MCINTOSH.

[1] Forty-second Annual Report, Fishery Board for Scotland, being for the year 1923. (Edinburgh: H.M. Stationery Office, 1924.)

Science and the Instrument Industry.[1]

THE British Scientific Instrument Research Association is fortunate in that most of its members are, by the nature of their work, in constant contact with research, and consequently in a position to know what it implies, and understand its methods and results. Many of these participating firms have, in fact, long been in the habit of carrying out original investigations in their own laboratories. They realise, therefore, the lines along which advance is possible and desirable, and, what is most important, they have had experience in formulating their problems in a scientific manner. On the other hand, the research staff of the Association has learnt to envisage the problems put before it from the manufacturer's point of view, and to adapt itself to practical needs and the limitations imposed by the necessity of economic production. The efficiency of this staff is very largely due to the good fortune of the Association in having as its director of research Sir Herbert Jackson, who is not only known for a variety of pioneer investigations in the realms of pure and applied science, but has also had a particularly wide experience of matters concerning instrument design, and of the psychology of the manufacturer. The Association is largely a body of his shaping, and he has made it a scientific instrument for the setting and solving of problems fundamental for the industry concerned.

The sixth annual report of the Association has just

[1] The Sixth Annual Report of the British Scientific Instrument Research Association, for the Year 1923-24. (London: 26 Russell Square, W.C.1.)

appeared At the end of it will be found a list of twenty-nine research reports which have been issued to members, to whom, of course, they are confidential. This is necessary to protect the participating firms against both foreign competitors and those British firms, fortunately few, which have elected to remain outside Very fittingly, both on account of the intrinsic importance of the subject to the instrument industry, and because the director is the leading authority on the chemistry of glass in Great Britain, a large number of these reports deal with problems concerning optical glass, such as the production of special glasses, including one asked for by the Admiralty, the preparation of neutral and coloured glasses, and the stabilising of polished glass surfaces, that is, the rendering of such surfaces immune from secular changes and the effects of climate This problem of stabilisation, and many of the other optical glass questions, are of particular importance to the fighting services, which depend so much on the use of optical instruments in a variety of conditions The fighting services are represented on the Council of the Association by representatives appointed by the Department of Scientific and Industrial Research, and their presence emphasises one of the services which the Association renders to the nation Evidence of the activity of the Association on the electrical side is offered by researches on magnetic properties of materials used for galvanometer suspended systems, and on certain X-ray problems

That the importance of the work done is realised by the Department of Scientific and Industrial Research, which controls the Research Associations, is indicated by the recent history of the Association, contained in the present report The Association has completed the first six years of its existence, and with them the period of its initial grant After investigations of the work of the Association by a special committee, including such experts as Sir Richard Glazebrook and Sir James Walker, the Department has resolved to offer an annual block grant of 10,000*l* on certain conditions which have been accepted, so that the Association has already entered upon its second grant period This period is characterised by certain administrative changes, among which the most important are those which bring the fighting services into closer touch with the Association, making them virtually members

The value of the Association to the instrument industry is not easily overestimated Apart from the actual researches which it carries out, it is often able to answer questions straightway from the knowledge which it has accumulated It acts as a centre of scientific activity, and has effectively introduced a spirit of co-operation among the participating firms, which is of the greatest promise for the future ability of the industry to excel foreign competitors The trust reposed in the director by all the members leads to a collaboration which would otherwise be quite impossible owing to trade rivalry, and there has already been an intercommunication of trade processes which has greatly benefited, for example, the various optical firms. Different firms, working in close touch with the research staff, have carried out in their own works and laboratories particular researches for which they have special facilities, and the results have been freely put at the disposal of all members This policy has already led to the production of certain instruments equalling, if not surpassing, those put on the market by foreign firms which, before the War, were supposed to be unapproachable

Between the National Physical Laboratory and the Association there exists a goodwill which is evidenced by the collaboration which has already taken place over the question of testing lenses by the Twyman interferometer and over certain other problems, such as the production of resistance wire. The Laboratory has always been a source of strength to the instrument maker in a variety of ways, but in the Association he has an engine which enables him to help himself in a way which no outside body can do Round the council table and in the sub-committees the members can thrash out questions both of technical design and of policy, avoid duplications of effort, and hear from one another and from outside members practical criticism and practicable suggestions, while the work of the research staff not only solves individual problems but also keeps constantly before them the high ideal of producing instruments not as good as, but better than, any yet on the market

The Botanic Garden, Copenhagen.

PROF OSTENFELD has prepared as a jubilee publication an account, referred to below,[1] of the history and resources of the Botanic Garden at Copenhagen. The contents of the work include many details of historical interest, while the botanist looking around for a continental school of botany will find much useful information in its pages

The Botanic Garden, now fifty years old, is the successor of one that, dating back to the close of the eighteenth century, had become inadequate Until 1871 the site was part of the old fortifications of the city, but by 1874 about twenty-four acres were transformed The old moat, rounded off, still exists as a lake, the view-point from which one sees the features of the garden extending in pleasant vistas up the rising ground on every side. Here the stately greenhouses, there the rock-garden, and in the background one or other of the scientific and public buildings which adjoin the garden. In recent years the trees have been collected into a special arboretum at Sorö, thus allowing space for a considerable extension of the rock-garden, and for special sections. Thus in the "Danish quarter" miniature chalk cliffs harbour the plants of Möen, and on other rocks and soils the native Danish plants are seen in their normal environment

The biological section is occupied by typical growth-forms such as might be expected in the home of Eugene Warming. The extensive glass-houses, in a compact block of more than 2000 square metres, include the higher palm-houses and lower ranges where tropical plants, orchids, aquatics, and other groups are housed. The more noteworthy plants, indoor and outdoor, are illustrated in the jubilee volume from photographs. The botanical museum shelters a mass of material, including special Danish, Arctic, and West Indian collections. The list of herbaria, more than two pages, is useful for any proposing to utilise them. The library of 25,000 volumes has been enriched by numerous donations. The Botanical Laboratory, dating from 1890, is a spacious block which is illustrated by a plan and photographs.

This home of Danish botany has been directed during the past fifty years by Joh Lange, F. Didrichsen, E. Warming (1885–1911), and C Raunkiaer, who was succeeded last year by C. Hansen Ostenfeld. The lists of staff include W. Johannsen, L Kolderup Rosenvinge, F Borgesen, and many others whose work has enriched the literature of botany Copenhagen has many advantages as a centre for the study of northern floras, and this memoir will prove a useful source of reference.

[1] "Botanisk Have gennem 50 Aar, 1874–1924." By C. Hansen Ostenfeld. Pp. 101. (København: G.E.C. Gads Forlag, 1924.) n.p.

University and Educational Intelligence.

CAMBRIDGE.—J. T. Irving, Gonville and Caius College, has been elected to the Benn W Levy Research Studentship in Biochemistry

The Governing Body of Emmanuel College offer to a research student, who is a candidate for the Ph.D. degree, a studentship of the value of 150*l* a year for two years Application should be made to the Master of Emmanuel College not later than July 31.

DUBLIN.—The Regius professor of physic in Trinity College, Dr John Mallet Purser, has made a gift of 10,000*l*, for the benefit of the Schools of Physic and Experimental and Natural Science, to be administered by a committee consisting of Prof J Joly, Prof A. F. Dixon and Prof W E Thrift The Board of Trinity College, in gratefully accepting this most generous gift, has expressed to Prof. Purser its desire that he should associate himself with the committee in the administration of the fund Prof. Purser has been connected with the teaching staff of Trinity College, Dublin, for 28 years, and during that period he has been to staff and students alike a source of inspiration and help, in the same way that Sir William Osler was to the scientific and medical schools at Oxford Prof Purser's many friends and pupils, not in Ireland alone, but in all parts of the world, will express the hope that he may long continue to hold his high position, and that he may still for many years to come preside over the School of Physic in the University to the service of which his life has been devoted.

LONDON.—A bequest of 5000*l*, subject to certain life interests, under the will of the late Mr. Arthur Jubber, has been accepted, the interest thereon to be used for scholarships, prizes, or lectures in any advanced subject, especially chemistry, botany, mathematics, ancient, modern, and natural history

The recognition of the London School of Economics as a School of the University in the Faculty of Arts has been extended to include the subjects of history and anthropology

The income of the Laura Soames Trust Fund for Phonetics is to be used for an annual prize in that subject.

The degree of D.Sc. (*Chemistry*) has been conferred on Mr. George Dean (West Ham Municipal College) for a thesis entitled "The Atomic Weights of Carbon and Silver."

The election of examiners for the matriculation examination for 1926 in the subjects of ancient history, botany, geography, geometrical and mechanical drawing, German, Greek, and modern history will shortly take place The necessary application form and particulars of the duties and remuneration of the office may be obtained from the External Registrar of the University, South Kensington, S.W.7 The completed form must be sent to reach the External Registrar by Monday, February 23, at latest.

MANCHESTER.—The Council has received from the General Electric Company of the U.S A the gift of an X-ray spectra apparatus for use in the Department of Physics

The following appointments have been made:—Mr. B. A McSwiney to be tutor and secretary to the Faculty of Medicine, Mr. B. Thomsett, assistant lecturer in electrical engineering in the Faculty of Technology; Mr. H. E. Martin, Whitworth meteorological observer.

The following resignations have been accepted:—Mr. H. Lowery, of the Department of Physics, on his appointment to a lectureship in the Technical College, Bradford; Mr. Ferris Neave, research assistant in entomology, on his appointment to a lectureship in the University of Manitoba.

OXFORD.—As was generally expected in the University, the vacancy in the Wardenship of New College has been filled by the election of the Right Hon H A L Fisher, member of Parliament for the Combined English Universities, and formerly president of the Board of Education As a Wykehamist in the fullest sense, Mr Fisher is certain to enter upon his duties as Warden of Wykeham's Oxford college with understanding and sympathy; while his distinguished career as an educational and administrative authority justifies the confidence which is widely felt in his ability to deal with the large questions of policy at present affecting the whole University There is every reason to believe that Mr Fisher, although his work as a writer and teacher has mainly lain in the department of modern history, will make his influence felt in the promotion of the best interests of natural science.

SIR AUBREY SYMONDS, second secretary of the Ministry of Health, has been appointed permanent secretary of the Board of Education, in succession to Sir Amherst Selby-Bigge, Bart

THE annual distribution of prizes and certificates at the Sir John Cass Technical Institute, Aldgate, London, E C 3, will take place on Tuesday, February 10. The awards will be distributed by Mr Sydney O Nevile, past-president of the Institute of Brewing, who will afterwards deliver an address on "The Fermentation Industries."

IN conjunction with the Development Commission the Departments of Agriculture for England and Wales and Scotland have instituted a new class of scholarships with the object of training those who desire eventually to take up posts as agricultural organisers or lecturers The scholarships are of two years duration, the first of which will be spent on investigational work in Great Britain and the second abroad The scholarship allowance in the first year will normally be 200*l*, the allowance in the second year will include provision for extra cost of travel and other expenses abroad The Development Commissioners have approved of the following awards—the first under this scheme H D Bennett (University College, Reading), F H Garner (University of Cambridge), V. Liversage (Harper Adams Agricultural College), T. Lewis (University College of North Wales), and A D Imper (Marischal College, Aberdeen)

FROM the Imperial College of Tropical Agriculture we have received a copy of its first detailed prospectus. The College, opened two years ago, trains students intending to become tropical planters, agricultural administrators or officers, or specialists, and offers facilities for study to graduates of other institutions. An important feature of the College is the provision for research and investigation which is afforded by its laboratories and fields, situated at St Augustine, seven miles from Port-of-Spain in the Island of Trinidad There are seven professors—of zoology and entomology, mycology and bacteriology, botany and genetics, chemistry and soil science, agriculture, economics, and sugar technology, and four lecturers, including one in veterinary science The ordinary diploma course covers three years. Fourth year courses are provided for specialisation in branches of agricultural science or chemical technology, in particular, sugar technology, and short (one-year) self-contained courses are also provided The College is at present non-residential.

Early Science at Oxford.

February 8, 1683–4.—Mr. Desmasters gave us a farther account of ye expansion of Ice He told us, that whereas the water he made use of lately (in some experiments of this kind, mention'd in the preceeding Minutes) was a sort of rough pump-water, which he has found turn milky and turbid immediately upon ye affusion of oyl of tartar *per Deliquium*, and considering also, that ye Ice made of this Water was a sort of rarified white Ice, he was hereby inclined to try, whether River water (which would readily mix with oyl of Tartar, without ye least precipitation) would, upon freezing, be expanded to ye height of ye pump-water above mentioned In order whereunto, he fill'd a glass tube of almost an inch diameter, with river water, to ye height of 6 inches (as he had done in ye former triall,) and then putting it to freeze in a mixture of snow, and salt, it gained but $\frac{1}{8}$ of an inch, after it was frozen, whereas ye pump-water got $\frac{3}{8}$ of an inch.

Dr Plot shew'd us some *Rosemary balls*, which are of ye nature of Mr Lister's Rust-balls, and were dug in Staffordshire, where they lye in lumps, in some of their Marl-pits Part of this stone apply'd to ye Magnet, after an hour's calcination.

A letter from my Lord Bishop of Ferns and Leighlin, mentioned a discourse of his Lordship's, preliminary to ye Doctrine of Sounds included in his letter. We received also a discourse from Mr. William Molyneux, concerning an optical Problem, which was read, and transmitted to ye Royal Society; Mr Bernard is desired to peruse, and consider it, as soon as it shall be returned from ye Royal Society, and give his thoughts of it to ye company.

February 9, 1685–6.—An Abstract of ye book of Fishes composed by Mr. Willoughby and Mr. Ray, printed by ye Royal Society, was read —Mr Cole of Bristol communicated an account of his observations on ye Purple Fish, for which the thanks of the Society were ordered.

February 10, 1684–5.—A Letter from Mr. Aston, dated Feb 2, was read It affirm'd (among other things) *That mortar is always without hair*; of ye truth of which we must own our selves not as yet satisfied.

Ordered—That Mr. Maunders, chaplain to Col. Luttrel, in Dorsetshire, Mr. Thomas, minister of Chard, and Dr. Turbervile of Salisbury, be asked what information they can give of ye late cold wind, which proved so fatal in Wiltshire, and Dorsetshire, about last Christmas Also that Mr Maunders be desired, as his occasions will give him leave, to draw up, and send us, an account of ye *Laver*, an Herb growing on ye rocks near Dunster Castle

An account of ye weather here at Oxford, December, January, and February last, taken by Mr. Walker, was by him presented to ye Society.

A letter from Mr Cuningham, dated St Leonards College, Jan 17, 1684–5, written to Mr. President, was read, It shewed his great readiness to procure us correspondents in Scotland; and contained a letter from ye reverend Dr. Skene, Provost of our holy Saviour's College, in St. Andrewes, to Mr. President, concerning ye establishing a Communication of matters Philosophicall, between this Society and ye learned Doctor, and his friends. It was ordered, that some of our Minutes be transcribed, to be sent ye Doctor, with the humble thanks of this Society for his compliance in this matter.

Mr. Standard of Merton communicated the results of his experiments on the weights of the several parts of Hens' eggs, weighed before and after boiling. The weighings were made with a pair of scales which turned with half a grain.

Societies and Academies.

LONDON.

Royal Society, January 29.—P. M. S. **Blackett**: The ejection of protons from nitrogen nuclei, photographed by the Wilson method Photographs have been taken of more than 400,000 alpha-ray tracks in nitrogen, using an automatic form of the Wilson condensation apparatus. A source of thorium B + C_1 was used, giving a mixed beam of 8·6 and 5·0 cm. alpha particles Among the tracks were found many normal forks due to the elastic collisions between alpha particles and nitrogen nuclei. In addition, eight forks were found of a strikingly different type. These abnormal forks represent the ejection of protons from nitrogen nuclei. Each track branches into two arms, one of which clearly represents the track of the proton. Since there is only one other arm to represent the tracks of both the residual nucleus and the alpha particle itself, the two particles must be bound together after the collision. When, therefore, a proton is ejected from a nitrogen nucleus by a fast alpha particle, the alpha particle itself is captured by the residual nucleus, forming a new nucleus which should have a mass of 17 and an atomic number 8.—R E. **Gibbs**: The variation with temperature of the intensity of reflection of X-rays from quartz and its bearing on the crystal structure Whilst the space group to which quartz belongs is known, the positions of the atoms in the molecule remain undetermined. The oxygen atoms cannot lie in the same basal planes as do the silicon, but must interleave them at a distance *d*. Of all the four unknown parameters, the variation of *d* alone will affect the intensity of reflection from the basal plane Reflection intensities measured from 0° to 800° C show that marked changes occur for all the planes at the transition point.—R. W **Gurney**. (1) Ionisation by alpha particles in monatomic and diatomic gases In the monatomic gases — xenon, krypton, argon, neon, and helium—the amount of ionisation increases with increasing atomic number, a result to be expected from their decreasing ionisation-potentials. In the diatomic gases—hydrogen, oxygen, and nitrogen—ionisation is less than in any of the monatomic gases, in spite of the high value of the ionisation-potential of helium. The ratio of the ionisation in the gases to that in air varies with the velocity of the alpha particles. The question is discussed whether the value (33 volts) found by Geiger for the average expenditure of energy per pair of ions in air is applicable to ionisation near the end of the range (2) The stopping-power of gases for alpha particles of different velocities. Since the stopping-power of a substance varies with the velocity of the alpha particles traversing it, the value obtained for the stopping-power of a gas by a measurement made over the whole or a large part of the range, as has usually been done, is merely an average value. Small portions of the range are here selected, so that the relative stopping-power has been measured for alpha particles of high velocity, of low velocity, and of intermediate velocity, separately. The relative values of the atomic stopping-powers tend to converge at the end of the range.—W. E **Curtis**: The Fulcher hydrogen bands The Fulcher lines and Allen's additions to them have been examined with the view of finding a theoretical interpretation of them. The wave-numbers of two of the strongest lines require correction by about 0·5 cm.$^{-1}$. The differences are then sufficiently regular to provide a criterion for the genuineness of the extra lines, which are in the main confirmed. The arrangement is consistent

with the view that they originate from combinations of simultaneously occurring rotation and vibration changes. New values of the molecular moments of inertia concerned are obtained which probably refer to an "excited" molecule. The nuclear vibrations within the hydrogen molecule seem to be very nearly simple harmonic, which would account, in conjunction with the small moment of inertia, for the unique structure of the system as compared with other band systems. The two sets of Fulcher triplets apparently originate from two molecules essentially similar in structure.—W. L. **Webster**. The magnetic properties of iron crystals. The magnetic properties may be accounted for by the Weiss theory of molecular fields. The magnitude of the molecular field is found for two crystals, giving respectively 620 and 479 gauss. The magnitude of the component along any one of the crystal axes varies as $\cos^4(\psi)$, (ψ) being the angle between the axis and the direction of magnetisation. The molecular field is a stable property of the crystal, and is affected considerably by the presence of impurities.—A. E. **Ingham** and J. E. **Jones**. On the calculation of certain crystal potential constants and on the cubic crystal of least potential energy.—E. C. **Stoner** and L. H. **Martin**. The absorption of X-rays. Two beams, defined by two slit systems, one vertically above the other, are reflected by the same crystal into two ionisation chambers. The beams are first balanced. A sheet of the absorbing material is then placed in the path of the upper beam, and the beams rebalanced by moving a wedge of aluminium across the path of the lower beam. The well-known law $\tau/\rho = \text{const}.\ Z^4\lambda^3$ holds only on the long wave-length side, or sufficiently far away on the short wave-length side of the K absorption discontinuity. Neither the formula of de Broglie nor of Kramers gives correctly the variation of the magnitude of the K group with atomic numbers. Measurements on the absorption co-efficients of uranium on each side of the three L absorption discontinuities show that the number of electrons associated with the L_3 level equals the sum of the numbers associated with the L_1 and L_2 levels. This is in agreement with Dauvillier's result for gold.—F. H. **Schofield**. The thermal and electrical conductivities of some pure metals. The maximum temperature used was 700° C. The thermal conductivity of aluminium increases with rising temperature, that of nickel decreases at first, and then above 500° C. increases. Copper, magnesium, and zinc showed, on the whole, slight decreases of conductivity with temperature. The values of Lorenz's function for copper, magnesium, and zinc were practically constant at all temperatures, that for aluminium showed a rise with increasing temperature; that for nickel showed a rise to 300° C., above which temperature it remained nearly constant except for an abnormal value at 400° C.—M. de **Sélincourt**. On the effect of temperature on the anomalous reflection of silver. The existence of a well-defined band in the ultra-violet (about 40 Å. in width) at which the reflection co-efficient of silver is negligible, has been utilised to investigate the relation between the frequency of the free electrons which are responsible for the reflection and the mean distance between the particles of the metal. The point of minimum reflection has been determined by a photographic method at the four temperatures 183°, −79°, 16° and 150°; the band is displaced in the direction of decreasing wave-length as the temperature is lowered, and is at the same time rendered sharper and narrower.—T. L. **Ibbs**: Thermal diffusion measurements. Mixtures of each of the following pairs of gases were used: hydrogen and carbon-dioxide, hydrogen and nitrogen, nitrogen and carbon-dioxide, hydrogen and argon, helium and argon. The apparatus consists essentially of a small cold vessel maintained at uniform temperature, joined by a connecting tube to a larger vessel the temperature of which can be raised as required to about 300° C. Thermal diffusion produces a difference in the distribution of the components of the mixture on the hot and cold sides, and the resulting change in composition on the cold side is measured directly by means of a katharometer, the open cell of which forms part of the cold side. There is a general tendency for the gas with the heavier molecules to diffuse towards the cold side. The total separation is nearly proportional to $\log T_1/T_2$ (where T_1 is the absolute temperature of the hot side, and T_2 the absolute temperature of the cold) in all cases.

Optical Society, December 11.—J. **Guild**. (1) An equipment for visual spectro-photometry. The equipment for visual spectro-photometry designed by the author and installed in the Optics Division of the National Physical Laboratory. The basis of measurement is Talbot's law as applied to rotating sectors. By employing a series of sectors the whole range of effective transmission from 100 per cent. to 0·01 per cent. is covered by a series of fixed points, each of which corresponds to a transmission about 90 per cent. of the next higher, with only a few sectors none of which is below 1 per cent. in its effective transmission. The gaps between the fixed points are covered by photometric wedges calibrated in terms of the sector discs. The field of the instrument is of the Lummer-Brodhun contrast pattern. (2) Transformation of trichromatic mixture data. Algebraic methods of transforming colour mixture equations from one trichromatic system to another are described. Measurements made in terms of the arbitrary working primaries of any trichromatic colorimeter can be transformed into any system of standard primaries or vice versa, without auxiliary measurements other than can be made on the instrument itself used in the normal manner.—L. C. **Martin**. A simple microphotometer. The addition of a few auxiliary parts, including a photometric comparison cube, permits an ordinary microscope to be used for finding the average density over a very small area of a photographic plate by visual methods. The instrument is useful with spectrograms and star images.

January 15.—W. H. **Steavenson**. A peep into Sir William Herschel's workshop. See NATURE, July 5, 1924, p. 21.—P. P. **Schilovsky**. Slow speed precision training gear governed from a distance. The increase in precision in the training of telescopes, microscopes, etc., is possible only if an electrical device, controlled from a distant station, is applied to the moving parts. The angular velocity of the training motor must correspond with that of the handle of the manipulator. Standard motors in which the speed of rotation depends upon load and output cannot be used, the only system available is one where the manipulator can revolve the magnetic field of a motor's element in strict conformity with the speed and direction of a distant device at the governing station.

Aristotelian Society, January 5.—G. Dawes **Hicks**: The dynamic aspect of Nature. The view that "force," in the sense of strain or stress, is a subjective phenomenon is devoid of justification. As it is requisite to distinguish the *perception* of a colour from the *colour*, so it is requisite to distinguish the *perception* or *feeling* of a strain from the *strain* which

we perceive or feel. Though the sun is not *conscious* of a strain when it pulls the earth, it does not in the least follow that in doing so it is not subject to a strain. On the other hand, one may legitimately argue that the "mind" or "self" is as such neither subject to a strain, in the sense in which that term is used of material things, nor to be conceived as putting forth energy. In willing, as indeed in cognising, the "mind" is certainly active, but the activity is not analogous to what is signified by the phrase "exertion of force". Further, there is no ground for the contention that what we are cognisant of as "force" or "energy" is confined to organic phenomena, a supposition which would necessitate a theory of vitalism cruder than any hitherto suggested. The truth rather is that modern physics, with its conception of "lines of force" and its doctrine of energy, presupposes the reality of the factors of stress and strain in the physical world. The concept of either "force" or "energy" as an entity *per se* is doubtless a pseudo-concept, but the notion of mass and energy as inseparably combined would seem to be a necessity for physical theory. The attempt to conceive of energy as the one physical reality and of matter as a derivative therefrom results simply in the materialisation of energy. A quantum of energy becomes to all intents and purposes a materialised body, although matter is supposed to be dispensed with. The paper concluded by criticising certain consequences which have been thought to follow from the general theory of relativity.

Mineralogical Society, January 20.—K. **Yardley**. An X-ray examination of calcium formate. The orthorhombic bipyramidal unit cell contains 8 asymmetric molecules. The dimensions are $a = 10{\cdot}19$ Å., $b = 13{\cdot}41$ Å., $c = 6{\cdot}27$ Å. The structure is founded on the Bravais lattice Γ_0, and belongs to the space-group C_{2h}^5.—John **Parry** and F. E. **Wright**. Afwillite, a new hydrous calcium silicate from Dutoitspan mine, Kimberley, South Africa. This mineral was found by Mr. A. F. Williams as large water-clear crystals. These are monoclinic. Analyses give the formula $3CaO\ 2SiO_2\ 3H_2O$ or $2H_2CaSiO_4\ Ca(OH)_2$. It has a slight alkaline reaction and is completely decomposed by dilute hydrochloric acid. Optical and crystallographic data are given in detail.—P. N. **Chirvinsky**: Tyuyamunite from the Tyuya-Muyun radium mine in Fergana. A review is given of the literature on the copper, vanadium, and uranium ores at this locality. The mineral tyuyamunite, $CaO.2UO_3\ V_2O_5.mH_2O$, is related to carnotite, having calcium in place of potassium. The microscopical characters of the minute orthorhombic crystals are described.—L. J. **Spencer**. International agreement in mineralogical and crystallographical nomenclature. With a small amount of "give and take" in different countries much greater uniformity could be attained for mineral names. For international purposes the correct spelling of the printed word is of more importance than the correct pronunciation. There is no necessity to provide well-established mineral-names with the termination *ite*. The Millerian notation for crystal planes is the best for international use. The principal optical directions are conveniently given by α, β, γ, corresponding with the three principal indices of refraction.

EDINBURGH.

Royal Society, January 12.—E. Leonard **Gill**: The Permian fish, Dorypterus. The external covering of Dorypterus consisted only of a series of large scales protecting the belly, of a curious cord-like row of spindle scales and a few scales upon the tail. The bony structures of the few examples which have been preserved, show that it belonged to the coral-fish type, that its body was exceedingly compressed and roughly circular in outline, and that its jaws, differing from those of any other known fish from the earlier deposits, show it to have developed a highly specialised mode of feeding. Its flattened body, comparative lack of scales, and limited amount of muscular tissue, necessitated that exceptional support should be derived from the bony skeleton, and hence the median plane has become filled with a development of bony spines and fin-supports, such as is scarcely equalled in any other fish. In this and other respects it shows general and remarkable convergence of adaptation to modern flattened fishes of the "John Dory" type, while in the placing of its paired fins its aspect is also modern. The investigation demands the formation of a new family for "Dorypterus," and a readjustment of its recognised place in the scale of fish evolution.—E. A. **Baker**. The law of blackening of the photographic plate at low densities. This investigation was undertaken at the Royal Observatory, Edinburgh, in order to supply the necessary physical data for a photometric study of stellar spectra. Such a study leads to the characteristic curve of radiative intensity of each star, and the determination of its temperature. But a prerequisite is the conversion from density on the photographic plate to the intensity of the illumination, for any wave-length. The instrument for measuring density is a photometer, constructed by the author, on the principle devised by Koch, in which the obscured and unobscured beams pass to two photo-electric cells and their effects are balanced against one another. The production of standard deposits representing definite ratios of the incident light was effected by means of screens pierced by standard apertures, registering upon the same spot and exposed separately or together. The values for different wave-lengths were secured by suitable colour filters. These are at present confined to the violet and the red, the filters not being sufficiently selective in the green. The results are expressed in the form of the determination of certain coefficients, equivalent to, and superseding the current statements of the inertia of the plate, development constant, and the departure from reciprocity indicated by Schwarzschild's index.—E. L. **Ince**. The vibrations of a stretched membrane with a particular law of density. Membranes the density of which diminishes according to the square of the distance from a fixed point were considered. The boundary is either circular, elliptical, or rectangular. For particular values of the constants the problem is simpler than in the case of uniform density. These simple cases are considered, and the problem is then dealt with more generally by an appeal to the Sturmian theory of differential equations.

VIENNA.

Academy of Sciences, November 20.—J. **Kaess**: Fermat's great theorem and its solution.—A. **Rollett** and A. **Schmitt**: On β-amyrin from Manila elemi-resin (third contribution).—K. **Stosius** and E. **Philippi**: The course of the action of ammonia on cinnamic acid ethyl ester.—M. **Nicolic**: The influence of light on the germination of *Phacelia tanacetifolia*. The germinating power of the seeds is in part completely destroyed, in part hindered, by continued illumination. The retarding action of light increases with the strength of the illumination.—F. **Dormann**:

The epidermal glands and excretion of resin in *Alnus viridis*.

November 27.—The vice-president announced the death of Sir Archibald Geikie, honorary member of the Academy.—S **Meyer**: Communications of the Radium Institute, No. 171. Coefficients of atomic magnetism for the rare earths. New determinations with the purest material from C. Auer-Welsbach and for hafnium from G. Hevesy. Cassiopeium and hafnium are as diamagnetic as lanthanum and zirconium. Tetravalent præsodymium has nearly the same atomic magnetism as trivalent cerium, and tetravalent cerium nearly the same as trivalent lanthanum. The results are important for the co-ordination of electronic orbits in Bohr's atomic model.—J **Kaess**. Construction of the angle 1° with compasses and ruler.—G **Weissenberger**, F **Schuster**, and N **Mayer**. On the molecular compounds of the phenols, VI. The behaviour of naphthols, tetrahydronaphthol, and allied compounds.

December 4.—H **Pettersson**: Communication of the Radium Institute, No. 172. The field of force of the atomic nucleus and Coulomb's law. Experiments seem to show that α-particles shot at the nucleus of certain elements are not reflected but remain at the nucleus. This, as well as the results obtained by Bieler, can be explained by considering the electrostatic induction between α-particle and nucleus on the basis of Coulomb's law.—J **Kaess**. Division of a circle into 7 and into 9 parts by ruler and compasses.—L. **Holzer**. Estimation of the units in a cubic number-body (Zahlkörper).—F **Raas**. The crystal form of the orthoclases. The growth velocities of single crystal surfaces are given numerically as relative central distances.—R **Mueller**, E **Pinter**, and K **Prett**: The electrochemistry of non-aqueous solutions, Communication VI. Experiments on the electrolytic deposition of some metals from solutions in amyl alcohol, acetonitrile, aniline, and chinoline.—B **Guth**. On the chemistry of the higher fungi, Communication XVIII. Investigations on the muscarine problem.—J. **Zellner**. On the chemistry of heterotrophic phanerogams, Communication V. The parasite *Prosopanche Burmeisteri* contains special tannoids.—J. **Pia**: Remains of a land plant in the Noetsch coal strata in the eastern Gailtal Alps. A new fern, Gymnoneuropteris.

Official Publications Received.

United States Department of Agriculture. Department Bulletin No. 1235: Life History of the Codling Moth in the Yakima Valley of Washington. By E. J. Newcomer and W. D. Whitcomb. Pp. 77+8 plates. (Washington: Government Printing Office.) 15 cents.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 26: Statistics of State Universities and State Colleges for Year ending June 30, 1923. Prepared under the Supervision of Frank M. Phillips. Pp. 15. (Washington: Government Printing Office.) 5 cents.

Chemistry in the Service of the State. Pp. 31. (Madison, Wis.: Department of Chemistry, University of Wisconsin.)

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1924. Edited by Prof. Alexander Meek. Pp. 121. (Cullercoats.) 5s.

Proposed National Institute for Research in Colloid Chemistry. The Need for such an Institute, the Plan for its Operation, an Argument for its Location, Letters of Commendation. Pp. 104. (Madison, Wis.: University of Wisconsin.)

University of Birmingham: Executive Board of Mining Research. Report on the Work of the Mining Research Laboratory, 1921–1924. Pp. 32. (Birmingham.)

Scientific Papers of the Institute of Physical and Chemical Research. Vol. 1, No. 12, March: Spectra of Constricted Arc of Metals. By Toshio Takamine and Mitsuharu Fukuda. Pp. 207-216+plates 5-8. 45 sen. Vol. 1, No. 13, August: The Fine Structure of Mercury Lines and the Isotopes. By Hantaro Nagaoka, Yoshikatsu Sugiura, and Tadao Mishima. Pp. 217-258+plates 9-18. 2 yen. (Tokyo: Institute of Physical and Chemical Research, Komagome, Hongo.)

Department of Agriculture. Science Bulletin No. 33. Report on the Cost of Production of Maize Investigation for the Season 1921–22. By E. Farrish. Pp. 46. (Pretoria: Government Printing and Stationery Office.) 6d.

The Marine Biological Station at Port Erin (Isle of Man), being the Thirty-eighth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 47. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1s. 6d. net.

The Botanical Society and Exchange Club of the British Isles. Vol. 7, Part 1: Report for 1923. By G. Claridge Druce. Pp. 366+6 plates. (Arbroath: T. Buncle and Co.) 10s.

Osmania University, Hyderabad: Publications of the Nizamiah Observatory. Astrographic Catalogue 1900.0, Hyderabad Section, (Part 2) Dec. −20° to −24°, from Photographs taken and measured at the Nizamiah Observatory, Hyderabad, under the Direction of T. P. Bhaskaran. Vol. 5. *Measures of Rectangular Co-ordinates and Diameters of 88,444 Star images on Plates with Centres in Dec. −21°*. Pp. xxxix+200. (Nizamiah Osmania University.) 15 rupees, 20s. net.

Trinidad and Tobago. Council Paper No. 105 of 1924. Agricultural Credit Societies. Report by the Registrar of Agricultural Credit Societies for the Year ended 30th June, 1924. Pp. 8. (Port-of-Spain.) 4d.

Bulletin of the American Museum of Natural History. Vol. 51, Art. 7. The Pectoral Limb of *Eryops* and other Primitive Tetrapods. By Roy Waldo Miner. Pp. 145-312. (New York.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 55. Bibliography of Educational and Psychological Tests and Measurements. Compiled by Margaret Doherty and Josephine MacLatchy under the Direction of B. R. Buckingham. Pp. ix+253. (Washington: Government Printing Office.) 25 cents.

Fifty-fifth Annual Report of the Trustees of the American Museum of Natural History for the Year 1923. Pp. xxiv+269+13 plates. (New York City.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 35. Rapport Atlantique 1923 (Travaux du Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Publié avec l'aide de Dr. Ed. Le Danois. Pp. 58+11 planches. (Copenhague: Andr. Fred. Høst et fils.)

Methods and Problems of Medical Education. (Second Series.) Pp. 11+118. (New York: The Rockefeller Foundation.)

Diary of Societies.

SATURDAY, FEBRUARY 7

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—L. Colledge: Demonstration of Kinematograph Pictures of Cases of Facial Paralysis treated by Nerve Anastomosis. G. J. Jenkins: Septicæmia as a Complication of Middle-ear Infection.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. H. Fellowes: The Elizabethan Ayre.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—Dr. J. R. Leeson: The Evolution of Man.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at Grand Hotel, Manchester), at 4.—V. C. Faulkner: A Psychological Examination of Foundry Life.

HULL ASSOCIATION OF ENGINEERS (at Hull Municipal Technical College), at 7.15.—J. Sim: Recent Developments in Marine Auxiliaries.

MONDAY, FEBRUARY 9.

ROYAL IRISH ACADEMY (at Dublin), at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—W. L. Calderwood: The Relation of Sea Growth to the Spawning Frequency in *Salmo salar*.—Prof. F. J. Cole: A Monograph on the General Morphology of the Myxinoid Fishes based on a study of Myxine. Pt. 6: The Blood Vascular and Lymphatic Systems.—Sir Thomas Muir: The Theory of Compound Determinants from 1900 to 1920.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. A. T. Clay: The Amaru.

BIOCHEMICAL SOCIETY (in Biochemical Department, University College), at 5.—H. J. Channon: Cholesterol Synthesis in the Animal Body.—G. A. Harrison and H. J. Channon: Observations on the Composition of Subcutaneous Fat in Cases of Sclerema Neonatorum.—C. R. Harington, S. A. S. Tri-iodophenyl-pyrollidone-carboxylic Acid.—J. C. Drummond and K. H. Coward: (*a*) Further Observations on the Chemical Nature of the Vitamin Fraction of Cod Liver Oil, (*b*) Ultra-violet Radiation and Growth.—S. Tsubura: Comparison of the Reducing Properties of Plain and Striated Muscle.—Dr. P. Hass and T. G. Hill: An Oxygen Absorbing Mechanism in *Mercurialis perennis* and Accompanying Colour Changes.—A. Wormall: The Tyrosinase-tyrosine Reaction: the Theory of Deamination.—F. C. Happold and H. S. Raper: The Supposed Deaminising Action of Tyrosinase on Amino Acids.—C. Rimington and H. D. Kay: The Phosphorus of Caseinogen (Preliminary Communication).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. V. E. Negus: Some Disorders of the Larynx.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Capt. P. P. Eckersley and others: Discussion on Broadcasting.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates Section), at 7.—K. Rowell: Recent Developments in Solid Injection Oil Engines.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. A. Gardner: Methods of Keeping Foundry Records.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine, Comparative Medicine, Disease in Children Sections), at 8.—Dr. Robertson, Dr. Niven, and others: Special Discussion on The Control of Tuberculosis and the Milk Supply.

SURVEYORS' INSTITUTION, at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. M. de Navarro: Ancient Trade Routes in Europe.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.), at 8.30.—Sir Thomas Horder, Bart., and others: Discussion on the Treatment of Lymphadenoma.

TUESDAY, FEBRUARY 10.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (at National Institute for Medical Research), at 4 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5 15 —Prof J Barcroft: The Colour of the Animal Creation (I) The Colour of Man.

ROYAL SANITARY INSTITUTE, at 6 —Maj.-Gen Sir Wilfred Beveridge, Dr W M Willoughby, and others Discussion on Food and Health

INSTITUTE OF MARINE ENGINEERS, at 6 30 — Presidential Address

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6 45 —S Ferguson: A General Survey of the High Tension Switchgear Field

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7 —F. G Woollard British Methods of Continuous Production.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Informal Discussion on Domestic Electrical Apparatus

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group), at 7 — Conference on the Standardisation of Plate Testing Methods: —Section IV The Measurement of Photographic Densities (*a*) Survey of the Present Position, (*b*) Standardisation of Photographic Densities, (*c*) Methods of Measurement Opening Paper by Dr C E Toy —Section V The Interpretation of Results (*a*) Plate Speeds The Hurter and Driffield and other Systems, (*b*) Inadequacy of these Systems Rôle played by the under, correct and over exposure portions of the plate curve Opening Paper by T Thorne Baker and O Bloch

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates Meeting) (at Broadgate Café, Coventry), at 7 15 —G H Day: Aluminium its Alloys and their Use in the Automobile Industry

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Section) (at 207 Bath Street Glasgow), at 7 30 —H W Taylor Three wire Direct-current Distribution Networks Some Comparisons in Cost and Operation

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7 30

QUEKETT MICROSCOPICAL CLUB, at 7 30 —D J Scourfield Asymmetry among Microscopic Organisms (Presidential Address)

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Meeting)

WEDNESDAY, FEBRUARY 11

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Old Colony Club, Aldwych House, W C) (Annual General Meeting), at 2 30: A H Barker Unsettled Questions in Heating and Ventilation

ROYAL SOCIETY OF ARTS, at 4 30 —Sir J Fortescue Flannery, Bart The Diesel Engine in Navigation

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5 —Prof R L Knaggs Osteitis Deformans, and its relation to Osteitis Fibrosa and Osteomalacia

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at 6 Queen Square, W C), at 6 —W E Tower The 14th Century Glass of Tewkesbury and its Recent Repair

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section, jointly with the Glasgow University Alchemists' Club and Institute of Chemistry) (at Glasgow University), at 7 —R B Pilcher Alchemists and Chemists in Art and Literature

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle on Tyne), at 7 —F H. Todd The Capital Ship as affected by the Washington Conference

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton), at 7 30 F G Woollard British Methods of Continuous Production

INSTITUTION OF CHEMICAL ENGINEERS (jointly with the Chemical Engineering Group of the Society of Chemical Industry) (at Institution of Mechanical Engineers), at 7 30 —O Brunler Internal Combustion Boilers — D. Brownlie Steam Generation under Critical Conditions

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8 30 —Dr B Malinowski Mate Selection in Primitive Society

THURSDAY, FEBRUARY 12.

ROYAL SOCIETY, at 4 30 —H Muir Evans A Contribution to the Anatomy and Physiology of the Air Bladder and Weberian Ossicles in Cyprinidæ —J S Huxley Studies on Amphibian Metamorphosis, II —*To be read in title only* —Prof A Dendy An Orthogenetic Series of Growth Forms in certain Tetraxonid Sponge Spicules — Dr C E Walker. The Meiotic Phase in Triton (*Molge vulgaris*) —W E Atkins *Clausilia bidentata* (Strom) and *Cl. cravenensis* (Taylor): A Statistical Enquiry into the Relationship of two Similar Species

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15 —Sir William Bragg The Properties and Structure of Quartz (III)

ROYAL AERONAUTICAL SOCIETY, at 5 30 —Col F Searle The Maintenance of Commercial Aircraft

ROYAL SOCIETY OF MEDICINE (*Tropical Diseases and Parasitology Sections*), at 5.30 Dr A F MacCallan: Ophthalmology in Egypt —Capt W. H Dye Schistosomiasis and Splenomegaly in Nyasaland

INSTITUTE OF MARINE ENGINEERS, at 6 30

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7 15.—Dr J Newton Friend. Iron in Antiquity

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7 30 — Prof A R Fulton: The Utilisation of Tides for the Production of Power

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7 45 — J H Shaw: The Services of the Electrical Engineer in the Post Office

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 8.—Annual General Meeting —Dr A. Barr: Presidential Address

OIL AND COLOUR CHEMISTS ASSOCIATION (at 8 St Martin's Place, W C.), at 8 —A A. Drummon Synthetic Resins.—R G. Browning: The Painting of Ships

SOCIETY OF DYERS AND COLOURISTS (Bradford Junior Branch) (at Bradford).—W. White: Wool Printing.

FRIDAY, FEBRUARY 13.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street), at 3 30 —P. A. Holliday: Submarine Engines and High-speed Heavy-oil Engine Electric Generating Sets.

ROYAL DUBLIN SOCIETY, at 4 30.

ROYAL ASTRONOMICAL SOCIETY, at 5 —Annual General Meeting —Prof. Eddington, Dr Jackson, Mrs. Maunder, and Prof. Milne: The Progress of Astronomy —Prof Fowler and Prof. Newall The Meeting at Cambridge of the International Astronomical Union —Dr. Dreyer: Tycho Brahe's Observations, Methods, and Results.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5 —Annual General Meeting —F E Smith: A System of Electrical Measurements (Presidential Address).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5 —Prof. S Cade: Regional Anæsthesia

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Gear Production Machinery.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M Adams. Concerning Children and Photography

INSTITUTE OF METALS (Swansea Local Section) (at Swansea University College), at 7 15 —Dr H Moore Season Cracking and its Prevention.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Swansea), at 7 30 —C A Seyler Microscopic Structure of Coals

JUNIOR INSTITUTION OF ENGINEERS, at 7 30 —L. Pendred Milestones in the Development of the Prime mover Locomotive

INSTITUTE OF METALS (Sheffield Local Section, jointly with the Sheffield *Metallurgical Association and other Societies*) (*at* 198 West Street, Sheffield), at 7 30.—Dr C. H Lander Fuel and its Efficient Utilisation.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle on-Tyne), at 7 30 — J W Hobson The Internal-combustion Locomotive.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9 —Dr B Malinowski: The Forces of Law and Order in a Primitive Community

SOCIETY OF DYERS AND COLOURISTS (Scottish Section) —I. E Weber. Hydrogen Peroxide and Bleaching

SOCIETY OF DYERS AND COLOURISTS (Manchester Junior Branch) (at Manchester).—K H Saunders A Paper

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Meeting)

SATURDAY, FEBRUARY 14

ROYAL INSTITUTION, at 3 — W Rothenstein The Artist's Relation to Social and Religious Life (I)

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4 —Sir D'Arcy Power. Hunterian Oration.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30 —V C Faulkner Some Notes on Refractory Materials

PUBLIC LECTURES.

SATURDAY, FEBRUARY 7

HORNIMAN MUSEUM (Forest Hill), at 3 30 —R P G. Denman. The Development of Modern Radio Communication.

MONDAY, FEBRUARY 9

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5 —Dr E B. Behrens: International Labour Organisation

BIRKBECK COLLEGE, at 5 30 — Dr G. G. Coulton Chapters in Medieval Education (II) Song and Grammar Schools

KING'S COLLEGE, at 5 30 —S Smith. The Nature and Influence of Babylonian Literature

UNIVERSITY COLLEGE, at 5 30 —Lt.-Commdr. E Sutton: Buddhism (Succeeding Lecture on February 16)

TUESDAY, FEBRUARY 10.

KING'S COLLEGE, at 5 30 — Dr E. Bevan The Hebrew and Greek Idea of God with special reference to Philo of Alexandria.

UNIVERSITY COLLEGE, at 5.30 —Dr C F Sonntag Man's Place in Nature (I). (Succeeding Lecture on February 24)

SIR JOHN CASS TECHNICAL INSTITUTE, at 8 — S. O Neville The Fermentation Industries

UNIVERSITY OF LEEDS, at 8 —Dr. W. H. Pearsall: Age and Development of Moorland Peat.

WEDNESDAY, FEBRUARY 11

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE (Physiology Department) (6 Giltspur Street, E C.), at 5 —Dr J M Duncan Scott The Medullary Centres (I) (Succeeding Lectures on February 18, 25, March 4.)

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—J. Adams The Principles of Design as applied to Pots and Pans

KING'S COLLEGE, at 5 30 —Sir Thomas Arnold: Arab Travellers and Merchants, A.D. 1000-1500

THURSDAY, FEBRUARY 12.

KING'S COLLEGE, at 5.30.—Prof. W. E. Soothill: China's Contribution to Western Civilisation

CENTRAL LIBRARY, 598 Fulham Road, at 8.—W P. Westell: Regional Survey.

FRIDAY, FEBRUARY 13.

KING'S COLLEGE, at 5.30 —Prof E Prestage: Vasco da Gama and the Discovery of the Sea Route to India

SATURDAY, FEBRUARY 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—B. Lovett: Natural History in Folk-lore.



SATURDAY, FEBRUARY 14, 1925.

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2885, VOL. 115]

Preservatives in Foods.

THE difficulty of drawing inferences of value in practical life from experimental work on animals or from observation on man could not be better illustrated than in the vexed question as to the legitimacy of allowing preservatives, especially boron preparations, in human foods. It is known that these preparations, when given steadily and persistently to animals, provoke renal inflammation ; it is commonly agreed, notwithstanding occasional medical testimony to the contrary, that they may be irritant to the human alimentary tract, and that they should be barred for young children, for invalids, and for sick persons It is also agreed that the elimination of a single dose of boric acid is slow, occupying five or six days, and that, therefore, most of us who live in towns are probably never free from boric acid in our systems from youth to old age It is, furthermore, common knowledge that boric acid or its salts are used largely in cream, butter, liquid eggs, margarine, potted meats, and are dusted over imported bacon and ham ; and that a person indulging in a varied diet may not impossibly, day by day, take an amount of boric acid which, even by the defendants of boron preservatives in food, would be regarded as inadvisable, if not actually injurious.

These and like considerations were before the Departmental Committee of 1900 and the more recent committee, the interim and final reports of which were summarised in the issues of NATURE for September 20 and December 13, 1924

The Committees also had before them the important consideration that the use of boron preparations is not unlikely to foster the continuance of less cleanly processes of food preparation and to conceal incipient and possibly dangerous stages of decomposition of food In this connexion, it is noteworthy that the prohibition of any preservative in milk has proved most successful, and has doubtless led to increased cleanliness in its production, transport, and storage. It has also been associated with increased use of pasteurisation, which may in some measure permit the continuance of relatively unsatisfactory production of milk , but, even so, pasteurised milk or cream represents a hygienic advance upon boricised milk or cream It is not surprising, therefore, that the recent Committee recommends that the use of boron preparations as food preservatives should be prohibited ; and the Minister of Health has indicated his intention to make draft regulations for this purpose. (For the sake of brevity, boron preservations alone are considered in this article)

Already there are indications that the proposed regulations will not be universally approved. Sir William Pope, professor of chemistry in the University

of Cambridge, has advanced in the *Times* weighty points for consideration. He regards the evidence of injury by boron preservatives as not convincing, and stresses the complexity of factors involved in human experimentation with such preparations, owing to the diverse factors concerned in the balance of health and disorder. Similarly, Dr. R Hutchinson writes stating that if injury from such preparations occurs, "it has entirely escaped the notice of medical men." Also, Prof F. W Tunnicliffe considers that in deciding against the use of boric preservatives "*a priori* argument has been drained to its dregs," and inadequate attention has been paid—as Sir William Pope had already suggested—to the danger of dearer and scarcer food, as the result of the prohibition of preservatives for perishable foods needing to be transported long distances At the least it appears to be suggested, let us postpone the prohibition of boric preservatives until the mass processes of production and transportation of perishable food have become perfected. Great waste of food is avoided by mass production Mass production is indispensable under modern conditions of life, and the means of transport within Great Britain do not permit, it is urged, even if those from other countries permit, of cold storage and transportation, to an extent which will avoid much waste of valuable food, if preservatives are forbidden.

As indicating the way in which politics may influence hygienic control, it is suggested that the prohibition of boric preservatives in Germany is, in part at least, enforced in order to keep out Canadian and American bacon and ham. The same effect might follow from a similar prohibition in Great Britain; and so we have illustrated the struggle and conflict of motives and aims which almost necessarily arise when any reform which is theoretically desirable is proposed. Motives of preferential trading may arise, the plea is entered that the proposed action will involve the wasting of much perishable food, and it is contended—as may easily be done—that the evidence of injury from the preservatives proposed to be prohibited is dubious and may even be non-existent.

These are reasons for proceeding cautiously, and there need be no extravagant fear that the Ministry of Health will proceed otherwise. But that the use of chemical preservatives is undesirable is, we think, indisputable, that their restriction and their extended restriction should be enforced, follows as a desirable reform, and in our view this restriction is not likely to be followed by increased scarcity of food, for we have every confidence in the ability of those concerned to improve their methods of manufacture and of transport, so as to obviate the need of any preservative except cold.

In deciding a complex practical problem like this, we are bound to consider the weaker members of the community, for whom doses of boric preservatives not producing recognisable symptoms in the majority, are likely to be serious, and this consideration alone suffices, we think, to justify extension of the present regulations against food preservatives in the direction recommended by the recent Departmental Committee. It has been urged that in this connexion Solon's advice to the Athenians should be followed: Have the best laws that can be kept, not the best laws that can be made. But past experience has shown that gradually increasing stringency in regulating food preservatives can be enforced, and that it is associated with better processes of preparation and transportation of food, and the next steps in this direction may be expected to have similar results.

Philosophical Biology.

(1) *The Study of Living Things: Prolegomena to a Functional Biology.* By Dr. E S. Russell. Pp. xx + 139. (London: Methuen and Co., Ltd., 1924.) 5*s.* net.

(2) *The Passing of the Phantoms: a Study of Evolutionary Psychology and Morals* By Prof. C. J. Patten. Pp. 95 + 4 plates. (London: Kegan Paul and Co., Ltd; New York: E. P. Dutton and Co., 1924.) 2*s.* 6*d.* net

(3) *Tantalus: or the Future of Man.* By Dr. F. C S. Schiller. Pp. 72. (London: Kegan Paul and Co., Ltd., 1924.) 2*s.* 6*d.* net.

As the reading public gradually accepts the doctrine of evolution and its corollary, the unity of life, a demand arises for books which deal, on one hand, with the application of biological methods and ideas to human life, and on the other, with an analysis of those ideas. With the narrowing of the gulf between man and the other animals, we find a quite legitimate tendency to interpret the mind of animals in terms of the human mind, and conversely. But such a procedure demands enormous caution, and one can scarcely hope to find the necessary critical attitude in books which are written to defend a point of view rather than to examine all sides of a problem. Yet they may justify themselves if they are sufficiently stimulating or attractive.

(1) Dr. Russell's book deals with the various methods by which biological problems may be attacked. After a passing reference to the purely morphological point of view, he briefly examines and rejects the materialistic conception of life, and points out its failure to explain the unity of the organism. Vitalism, that is, the theory that an organism consists of inert matter plus a soul or entelechy, is shown to have its own difficulties without solving those of materialism. So far Dr. Russell is in agreement with J. S. Haldane, whom

he quotes at length. But he regards Haldane's position as essentially a half-way house, also tenanted by J. B. Watson, to his own psychological outlook. "I know myself," he says, "as a psycho-physical unit or individuality, not as an immaterial entity acting upon an external material object, my body." It is from this point of view that he considers the behaviour of other organisms as exemplified not only by movement and secretion, but also by such activities as growth. The latter half of his book is taken up with the attempt to apply this view in detail. For example, it is suggested that the growth-regulating secretion of the thyroid gland "acts not directly by virtue of its specific chemical constitution, but indirectly by virtue of its meaning or significance, being perceived or sensed in an elementary way by the organs and responded to in the functional or psychobiological sense."

Apart from his complete neglect of such difficulties for a monadistic view as are presented by fission or conjugation, for example, we are inclined to regret that Dr. Russell does not push this point of view to its logical conclusion. From a strictly psychological point of view he has no business to talk about internal secretions, and adrenaline, for example, is not an aromatic amine from his point of view, but simply an element in certain emotional states. As it is, we feel that he tends to use physics and chemistry so long as they suit him, and adopts a psychological point of view when the complexity of the physico-chemical situation becomes intolerable. But few biologists achieve consistency in their hypotheses, and we can recommend Dr Russell's book to all who are interested in the philosophical side of biology.

So far man has only learned to think on two lines, one which enables us to deal with our fellow-men and the higher animals, the other with inanimate objects; but it does not follow that these are the only possible types of thought. Perhaps some intermediate outlook, which preserves the unity attributed to the human individual though without his memory or foresight, may prove valuable in dealing with lowlier organisms or with our own unconscious behaviour.

(2) Prof. Patten's book, after a thumb-nail sketch of evolution, plunges into animal psychology; and human attributes, such as admiration, imagination, and superstition, are assigned to birds and mammals. The bearing of animal on human psychology is discussed, with special reference to the origin of human superstitions, which include all beliefs in supernatural beings. The book makes no attempt to be either scientific or exhaustive, but it is so charmingly written that we believe it will find many readers. It is clear that the author is a real lover of animals, and if his love leads him into a perhaps unduly confident belief that they are on the whole virtuous and happy, it inspires a number of delightful anecdotes of animal behaviour. His religion, a sunny rather than philosophical pantheism, springs directly from his love of Nature. There is little that is novel in the book, but the author's point of view is worth restating from time to time. As a means of bringing home the reality of evolution to the average child of sixteen or so, we feel that it might be of real value in school libraries.

(3) "Tantalus," who here represents humanity as a whole, is a philosopher's reaction to biology The reaction is sometimes rather naive, as when he pauses to wonder that from the biological point of view man has not evolved in the last thirty thousand years. Critics of their fellow-creatures, and particularly of the present Government, would do well to remember Lingula, which has scarcely changed in the three million or so centuries that have elapsed since Ordovician times Dr. Schiller very rightly stresses the fact that in our society those social classes which we admire most are reproducing themselves most slowly, but some of the reasons given for this fact are, to say the least, unconvincing For example, the author alleges that the advance of medicine has enormously diminished selective mortality and improved the chances of weaklings to survive and leave descendants The contrary case could be argued, for in the last two centuries epidemic diseases such as smallpox have almost disappeared, and more chronic complaints such as tuberculosis, which kill far less indiscriminately, have remained with us The question whether the differential birth-rate may not be due to certain economic features of our civilisation rather than to its philanthropy and hygiene is scarcely considered.

With regard to the traditions which constitute man's non-biological inheritance, Dr. Schiller is equally gloomy. Perhaps it is a too intimate acquaintance with compulsory chapel and university examinations which prompts him to ask, "How many religions have perished from ritual sclerosis, how many sciences have not been degraded into pseudo-sciences or games?" He suggests two ways out of the impasse, one being the practice of Christian ethics, the other of eugenics He believes that history has shown that humanity as at present biologically constituted will not accept the former. He has more hope of the latter, provided we realise that our whole procedure is essentially experimental. He has also some confidence in the future of applied psychology. The scientific reader who is interested in the reaction of biological ideas on the mind of an intelligent outsider, or wishes to see the case for eugenics briefly stated without the display of too much class or racial prejudice, would do well to buy this little essay. J. B. S. H.

The Study of Agricultural Economics.

(1) *Elements of Land Economics.* By Dr Richard T Ely and Edward W. Morehouse. Pp xviii+363. (New York . The Macmillan Co , 1924.) 17*s*. net.

(2) *Introduction to Agricultural Economics* By Dr Lewis Cecil Gray (Social Science Text-Books.) Pp. xii+556. (New York The Macmillan Co , 1924.) 12*s* net

(3) *Elements of Rural Economics* By Prof. Thomas Nixon Carver Pp. v+266 (Boston and London : Ginn and Co., 1924) 7*s* net

(4) *Farm Accounts.* By C S Orwin (Cambridge Farm Institute Series) Second edition, revised. Pp vi+140. (Cambridge At the University Press, 1924) 5*s* net.

(5) *A Short System of Farm Costing* By H. R J Holmes Pp 107. (London . Oxford University Press, 1924) 6*s* 6*d* net

(6) *Farm Accounting* By Prof E L Currier, Prof N. J Lennes, and Prof A S Merrill Pp ix+287 (New York · The Macmillan Co , 1924) 7*s* net

MEN of science, in the first instance dubbed "Improvers," have been continuously at work for at least a century and a half investigating such problems as those involved in animal- and plant-husbandry, manuring, and the mechanics of agriculture. Systematic study of the other, or economic, side of the industry has been undertaken only within the last decade Research work under this head may imply the compilation of elaborate cost-accounts, comparison of various methods of farming, investigation into the pros and cons of large or small-holdings or the distribution of various forms of land-tenure, inquiry into the profits accruing to each class of person engaged in the industry, study of marketing systems, and so on. Into each of these fields individual workers have gone before, but that all-important factor, continuity of effort, has, until recently, been lacking. It is, for example, possible to recover the most elaborate records of the working of particular manors more than six hundred years ago ; in the seventeenth century Henry Best minutely investigated what we should now describe as the "economy" of North-country farming ; a hundred years ago, full statements of farm accounts kept in Norfolk and other arable counties were published

Generally, the efforts of those responsible for these pioneer investigations were ridiculed ; at best they were made the subject of acute controversy. For example, in Scotland, the publication in 1823 of an article "showing the expense and value of the produce of a Lothian farm during the late war" was thus welcomed by an anonymous farmer : "Try Mr. Scott's statement by what standard you may, and inform me wherein consists its merits. If it be considered a production of imagination, or of reflection, it is inferior to a nursery tale , as a work of instruction, or of utility, it is fallacious and ill-judged , as a statement of Lothian husbandry it is little short of a libel." Again, an eighteenth-century advocate of small farms thus delivered himself to a pamphleteer on the opposite side · "The fiend who wrote this was in all probability never beyond the stench of the infernal abode wherein he dwells !"

If controversies are still engendered on the latter subject, and apathetic reception upon occasion rewards the efforts of Mr Scott's successors, there is no doubt that the vast majority of agriculturists appreciate that there exists nowadays a new, and possibly valuable, means of approaching rural problems. In Great Britain, since the War, successive Governments have granted increasing sums towards the extension and maintenance of services charged with investigational and advisory duties. Nor is interest confined to this country, for, judging from reports emanating from Japan, the United States, Switzerland, and Denmark, it may be confidently stated that the movement towards a closer study, and therefore a better understanding, of farming conditions and rural economics is widespread. A natural corollary is the appearance of numerous publications, either dealing with the history and general principles of the subject, or confined to particular sections. In both classes the United States is well represented

(1) The first book on our list comprises an elaborate analysis of the utilisation of American soil. Its authors have produced a work which is bound to be of considerable value to American students, and one that is very suggestive to those European readers who are interested in the problems raised during the transition of a vast territory from a natural condition to a state aptly illustrated by the frontispiece, entitled "Airplane view of Manhattan Island, New York City." The distribution of the various categories of soil is well described, and successive chapters deal with its utilisation, for his varying requirements, by man, his access to forest and mineral products, and the provision of credit ; they also touch on what are to us such familiar and vexed questions as the taxation of "increments in land values." The volume is well produced and contains excellent diagrams and illustrations, but it contains scarcely any reference to conditions existing elsewhere.

(2) Dr. Gray's book is of more general interest to European readers. The author is an official of the United States Department of Agriculture, and he has produced a book which covers a wide field, ranging

from the enunciation of general economic theories down to advice on the marketing of fruit. He does not disdain reference to conditions existing in other countries, and his views on numerous rural problems will be read with respect by students therein. His twenty-six chapters all conclude with "Questions on the text," which do not detract from their value, but tend to emphasise the American origin of the work itself. The diagrams are excellent; particular praise must be given to the maps, produced by the author's own Department, showing the distribution of crops and of different-sized farms, a form of activity in which Great Britain has hitherto lagged behind the United States; fortunately, however, within a short time matters will have been rectified in this respect. Dr. Gray's work is admirably produced, and its moderate bulk is disproportionate to the number of its pages.

In (3) is found a work from the pen of a professor of political economy, which, to British ideas, is more orthodox in its treatment of the subject. The general history of agriculture is not neglected, for reference is made to village communities and the manorial system, and the names of certain English writers of long ago are mentioned. The author exercises considerable restraint when dealing with such contentious questions as co-operation and land-tenure, and has always at hand appeals to economic laws to enforce his arguments. He has produced a small, but scholarly, work which will not only be read with interest by British economists, but will also be retained on their bookshelves. Diagrams similar to those above referred to are again prominent.

(4) Mr. Orwin is undoubtedly the recognised authority on farm accounts in Great Britain, and it is largely through his persistent efforts during recent years that the great advantages to be obtained from the accurate keeping of "costings" has gained wider recognition amongst the farming community. In the latest edition of his book will be found clearly mapped out the procedure to be followed in farm costing. The author has enumerated the various principles involved in a straightforward way which should make the volume of the greatest use to farmers and students who have had no very great experience in book-keeping. The underlying principle to be grasped is that the balances of the apparently unproductive accounts (for example, labour, rent, foods, and manures) are charged against the productive accounts in the proportions in which the latter have benefited from them. This involves the keeping of records of labour, both manual and horse, and of rations fed to stock. Mr. Orwin gives examples of appropriate labour and ration sheets, and explains the method of their analysis; complete and up-to-date cost accounts of a Gloucestershire farm add to the value of the latest edition of what is admittedly a standard work in its subject.

Mr. Holmes in (5) has somewhat missed the aim of his endeavour to maintain simplicity as the primary object in preparing this volume. Those farmers for whom his book is intended as a guide will be inclined to give up the task of trying to master costing principles when they read that not only must a record be kept of the number of days grazed by each class of stock, and these eventually converted into "sheep-equivalents," but also that the manurial residues of foods fed on pastures must be calculated. It is not to be denied that such records can be kept with advantage on certain types of holdings, but on small farms, and where live stock is of diverse types and ages, it is questionable whether the degree of accuracy with which such information could be compiled would warrant the laborious calculations involved. Mr. Holmes advocates the "Standard" method of valuing cows and breeding stock. In this he is undoubtedly right, as in times of fluctuating prices, paper profits and losses are thus eliminated. The volume contains a full set of accounts for the year 1920–21 on a dairy farm of some two hundred acres.

As a text-book designed for school study in the United States, (6) can be recommended on account of the large number of exercises and "Topics for discussion" appended to each chapter. The first part deals with methods of making an inventory and financial statement, the second is confined to financial accounts, while the third deals with cost accounts and methods of recording data. As a treatise for British readers it is of interest in presenting arguments in favour of the adoption of general principles other than those commonly recognised in this country. Some of those advocated are open to criticism. For example, the authors recommend that interest on the average investment of capital in each branch of the farm should be charged against its cost, and also that a charge should be made against cost for the value of the farmer's own labour. Again, in regard to home-produced foods fed on the farm, they state that "an intermediary product which may readily be marketed should be charged at its farm value and not at its cost of production. Other intermediary products should be charged at their cost of production." The accepted practice in Great Britain, that of charging all intermediary products at cost price, appears to be much the sounder of the two methods. The volume contains cost accounts typical of conditions in Kansas and Iowa. American currency, however, and such expressions as "chores," "shelling," and "snapping corn" render them of doubtful utility outside the continent of North America.

J. A. VENN.

The Chemistry of Flour Milling.

Modern Cereal Chemistry. By D. W. Kent-Jones. Pp. ix + 324 (Liverpool: The Northern Publishing Co., Ltd., 1924.) n p

THE chemistry of wheat flour, and the elucidation of the factors influencing the "strength" or baking quality of flours from different wheats, present problems as complicated and difficult as any to be found in food chemistry. Recent research has thrown much light on some of these problems, and the author, who is well known as an authority on flour chemistry, is to be congratulated on having given a connected and critical account of the important work done on this subject during the last few years.

The English miller draws his wheat from almost every wheat-producing country in the world. Many of these wheats differ enormously in their strength or ability to produce a good loaf, that is to say, a large well-risen loaf possessing a certain silky and finely vesiculated texture. The author, in his chapter on the colloidal chemistry of flour, discusses the relative importance of various factors in the production of strength. The actual amount of gluten present and its physical character, the degree of colloidal dispersion of gliadin and glutenin, the hydrogen ion concentration of flour and the extent to which it is "buffered," the enzymic activity of the flour and the relative amount of yeast food present, are all more or less concerned in determining strength or weakness in a flour. The author is clearly on good terms with the most recent work on the colloidal chemistry of flour, and has given in this chapter an able review of present-day knowledge in this field.

It is when the author comes to the chapter on bleaching and flour improvers, on p. 165, that he treads heavily on dangerous ground. He adopts wholeheartedly the attitude that the artificial bleaching and improving of flour by nitrogen peroxide, chlorine, nitrogen chloride, peroxides, persulphates, acid phosphates, etc., is completely justifiable and beneficial both to the trade and to the consumer. In fact, he is at such pains to emphasise the entirely harmless character of these additions that the suspicions of the reader may well be aroused, and he may be led to inquire more closely whether the introduction of one pound of pure chlorine gas into a ton of flour is, in fact, entirely without effect on the consumer's health, whether there may not be some subtle action on the flour, affecting, ever so slightly, those vital principles which food manufacturers are never tired of claiming for their products, and whether the oft-repeated argument that no one has ever been able to prove injury to health from such additions is good enough where the most important foodstuff of all is concerned. To attempt an answer to these questions would, however, be outside the province of a reviewer.

The concluding chapters dealing with conditioning, moisture in wheat and flour, and analysis of flour are excellent. The book may be warmly recommended to all interested in the chemistry of flour, on the understanding that the Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food be glued to p. 165. G. W. M.-W.

New Measurements of Atomic Masses.

Isotopes. By Dr. F. W. Aston. Second edition. Pp. xi + 182 + 5 plates. (London: E. Arnold and Co., 1924.) 10*s.* 6*d.* net.

IT is seldom that a natural philosopher has made a subject so peculiarly his own as Dr. Aston has done with the experimental investigation of isotopes. At the present time, about fifty non-radioactive elements have been examined for isotopes, and all except half-a-dozen or so are among Dr. Aston's trophies. It is not, apparently, so much that other workers have stood aside as that the technique is not quite so simple as a casual description of the experimental method might suggest to the inexperienced. About two years ago, Dr. Aston published a general account of his work since the War under the title "Isotopes," and, as was to be expected, a second edition was soon demanded, which has now made its appearance.

As reference to the table of isotopes on p. 107 will immediately show, in the interval of two and a half years, more than twenty new elements have been investigated for isotopes by the author, so that at the time of writing, all the elements from atomic number 1 to atomic number 39 have been worked through, and many in the range 39 to 80. A beginning has been made with the elements of the rare earth group. The additions are mainly due to the development of the method of accelerated anode rays by the author. A salt of the metallic element to be investigated is made into a paste with graphite, and this paste, packed into a small tube, is used as the anode, and bombarded with cathode rays. The instability of the discharge consequent on the release of gas from the anode is avoided by a skilful device consisting of a subsidiary cathode and a kenotron valve. It is indicative of the troublesome nature of the work that even Dr. Aston himself records that when the apparatus was working sweetly, he analysed six elements successfully in as many working days, but that after it had been dismantled and set up again so as to be, apparently, exactly the same as before, he was unable to obtain any results of value for some weeks. When conditions are favourable the method gives excellent results.

The accuracy which Dr Aston now obtains in his measurements is emphasised by the fact that he is able to direct attention to a departure from the whole number rule shown by certain isotopes, notably those of tin This departure of the atomic mass from a whole number (oxygen, of course, being taken as 16) amounts to only two or three parts in a thousand, yet seems to be definitely established. It does not appear possible at present to draw any very precise conclusion from this observation. To avoid disturbing our ideas the effect may be attributed, in a general way, to some "close packing" of the same kind as prevents the masses of the general isotopes being whole numbers in terms of hydrogen as unity, but so little is known of the structure of complex nuclei that this is, in effect, simply a shelving of the matter until further measurements, of even higher accuracy, shall become possible The few cases of departure do not appear as such in the tables of isotopes, since a new term, "mass number," has been introduced in place of the old "mass of isotope" This is defined either as the number of protons in the nucleus or as the nearest whole number to the mass expressed in terms of oxygen as 16: both definitions amount to the same thing Since the departure is a minor matter, at any rate in the present state of our knowledge, this term is a timely one which serves, as good terms should do, to avoid inaccuracy on one hand and circumlocution on the other

The book contains many references to relevant results of other researches which have been carried out in the last two or three years, such as the work of Rutherford and Chadwick on nuclear disintegration, and the investigations of Ellis on nuclear γ-rays A rather fuller account of Fajans' speculations on relative stability of nuclei might have been welcome, since they are both more intelligible and more fruitful than most of the conjectures on this subject. The detection of an isotope effect in band spectra is also discussed, but, it may be said, it is by no means certain that the boron nitride bands of Jevons, on which there has recently been discussion in the correspondence columns of NATURE, are really monoxide bands, as Mulliken wants them to be, theoretically desirable as it may be for them to be so.

The paper on which the second edition is printed is a great improvement on that of the first, and it is pleasant to be able to acknowledge, in these dear days, that the book is very reasonably priced. In place of a final word of commendation, which is superfluous in this case, may be ventured the anticipation that in another year or two Dr. Aston will bring out a new edition recording the remaining thirty or so non-radioactive elements as satisfactorily sorted out into their isotopes. It seems very probable. E. N. DA C. A.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature and Art during the Session 1923–1924 by numerous Societies and Government Institutions Compiled from official sources Forty-first annual issue Pp. vii+405. (London: C Griffin and Co., Ltd., 1924) 15s net.

THE issue of this Year-Book for 1922–23 did not appear until the summer of 1924 this was somewhat late for a reference book dated for 1923. The publishers deserve our gratitude, therefore, for the promptness with which they have produced the volume for 1924 This forty-first issue has already started on a career of usefulness in our hands, which will continue until, and even after, the volume for 1925, which we hope to see in due course, has been published

Compared with last year's Year-Book, that for 1924 has been increased by sixteen pages, and we understand that seven societies have been added to the list. The increase affords some measure of the steady and healthy progress of scientific thought in Great Britain. As usual, the entries are grouped conveniently according to subject, and in each group there is a further subdivision into societies in London, the provinces, Scotland, and Ireland Under each entry is included the address, officers, meetings, conditions of membership, and publications of the society or institution in question, and in many cases the titles of papers read during the session 1923–24 follow Valuable summaries of the work during the year of such public institutions as the Royal Observatory, Greenwich, the National Physical Laboratory, and Rothamsted Experimental Station are also given Our thanks should be added to those of the publishers to the officials whose replies to requests for detailed information have made it possible to issue such an "official" volume It was probably too late for insertion that the new address of the Royal Dublin Society at Ballsbridge, Dublin was announced.

In turning over the pages, we have found the British Photographic and the British Cast Iron Research Associations (the former not indexed), but none of the score or so of the remaining industrial research associations The volume as it stands is, however, a valuable work of reference, which all who would keep in touch with scientific movements in the British Isles would do well to have at hand.

Auxiliary Tables of the Survey of India. Fifth edition. Revised and extended by Dr J de Graaff Hunter. Part 1: Graticules of Maps Pp 25 (R. 1=2s) Part 2: Mathematical Tables. Pp xiii+89 (Rs. 2=4s) Part 3: Topographical Survey Tables. Pp. xxi+52. (Rs. 1 8=3s.) (Dehra Dun: Trigonometrical Survey, Part 1, 1921. Part 2, 1924. Part 3, 1923.)

THE work of the Survey of India, especially in the domain of geodesy, has a world-wide reputation. The first edition of these tables, which are intended to facilitate calculations connected with survey operations of all kinds, appeared so long ago as 1868 They have more than once been copied and adapted by the surveys

of other countries, though, of course, they are primarily intended to apply to the methods and scales used by the Survey of India.

Part 1 contains tables for the projection of maps falling within the latitudes embraced by India: on the polyconic projection, which is that employed for the larger scale topographical maps, on the modified secant conical for small scale and general maps; and a table for the projection of the sheets of the *Carte International*, on the millionth scale, of which India has produced so many sheets. Part 2 displays a series of mathematical tables in general use in survey operations, also metrical equivalents; mathematical and physical constants, geodetic data (fundamental co-ordinates adopted by the Survey of India), and, at the end, a few pages of useful mathematical formulæ. Part 3 comprises a set of tables covering all the ground required by the topographical surveyor in his triangulation and astronomical work in the field.

These tables are a considerable advance on the previous editions, and Dr. Hunter deserves great credit for the way in which they have been presented. They have been prepared most carefully so as to assist in the solution of almost any problem with which the surveyor is likely to be confronted. The plan of publishing each part separately has added very much to their convenience for use in the field or office.

Part 4, Geodetic Tables, is under compilation, and may shortly be expected; while Part 5, explaining the forms and formulæ in use in the Survey of India, is in contemplation. The parts already issued contain full explanations of the tables, and also, in most cases, examples showing how the tables are used in practice.

H. L. CROSTHWAIT

Travaux pratiques de physique générale exécutés à l'Institut de Physique de la Faculté des Sciences de Strasbourg en vue du certificat d'études supérieures de physique générale. Par Prof. H. Ollivier. Première série: Sujets de 45 manipulations, réparties en 30 séances de 4 heures. Pp. 104+9 planches. (Paris: J. Hermann, 1924.) 12 francs.

PROF. OLLIVIER'S "Cours de physique générale" has already been the subject of favourable notice in these columns. The present volume on advanced practical physics maintains the high standard we have been led to expect from the professor of physics of the University of Strasbourg. It forms the first part of a treatise on the subject, and contains an account of those experiments which are repeated each year by all students attending the advanced course. It is assumed that the student has already attended an elementary laboratory course, is familiar with the theory of many of the instruments, and has a fair knowledge of mathematics. Classical experiments predominate in this first volume, and the apparatus used is carefully constructed and tested. Many of the instruments described are expensive, and students are expected to use them with the utmost care and to obtain results of a high degree of accuracy.

The experimental hints and cautions given in the text are most valuable, and all teachers will appreciate the "recommendations générales," prominently displayed early in the course: "Il ne faut toucher avec les doigts ni les parties graduées des appareils, ni les verniers, ni les poids de précision, ni les pièces optiques: lentilles, miroirs, nicols, lames quart d'onde, etc." Amongst the experiments we note with special interest Rowland's method of determining the mechanical equivalent of heat, the use of the stroboscope, photography, including photography in colours by the Lumière process (in this case no directions are given), a study of elliptically polarised light (arranged by M. G. Foex), magnetisation of an iron ring using a fluxmeter, and the behaviour of a three-electrode lamp. A novel and interesting feature in a text-book of practical physics is the series of nine plates containing excellent photographs of the Institute of Physics of the Faculty of Sciences of Strasbourg and of the apparatus arranged for experimental work in the laboratories.

H. S. A.

An Introduction to the Study of Cytology. By Dr. L. Doncaster. Second edition. Pp. xiv + 280 + 24 plates. (Cambridge: At the University Press, 1924.) 21*s*. net.

IT is not always that literary ability and scientific method are wed together in sufficient degree to produce a sound scientific text-book which is, at the same time, of literary merit. In recent years few famous biologists have possessed both these qualities in greater degree than the late Prof. Leonard Doncaster. It is, therefore, with special pleasure that we welcome the appearance of a second edition of his well-known book on "Cytology."

A monograph on any highly specialised branch of study has one great advantage over a work produced by the collaboration of a number of authors in that it possesses a greater unity of purpose, as the conception of a single mind, than could be produced by the most successful team work. In this respect all must admit that Prof. Doncaster's book is pre-eminent. But to maintain this quality becomes a most serious difficulty to the editor of a posthumous edition. This Mr. Grey has admirably overcome, and, although introducing much new and useful material, has in no way detracted from the arrangement and theme of the book as a whole.

The book would have been improved, perhaps, if more space had been given to the recent extensive advances in our knowledge of the cytoplasmic inclusions. Further, we cannot help feeling that much too little space is devoted to a consideration of the various types of cells of the soma of higher forms, for almost the entire book is concerned chiefly with the reproductive processes of gametogenesis, fertilisation, and segmentation.

The production of the volume is excellent, and we are pleased more especially with the illustrations. We consider the edition a well-written and instructive text-book for the student and research worker.

F. W. ROGERS BRAMBELL.

A School Chemistry. By O. J. Flecker. Pp. viii+238. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 3*s*. 6*d*. net.

AMONG the minor compensating advantages of the War period was the check given to the ever-rolling stream of text-books on elementary science, but now that paper and printing are less costly, the tide appears to be rising again; let us hope it will not overwhelm

us. The young and aspiring teacher may be commended for his zeal in writing a text-book for his own use—authorship invariably impresses a literary headmaster and a governing body—but it is a question whether his time would not be better spent experimenting in the laboratory and in keeping well abreast of modern developments. It is another matter if he has something really novel to say, or some new method of arrangement or presentation Unfortunately, however, originality seems to be somewhat elusive since the salad days of Ostwald, Alexander Smith, and Armstrong, and the present little work, like scores of others, does not excel in this respect The book has its merits; it is well written and particularly well spaced; the explanations are clear, and there is very little to criticise on the score of choice of experiments or of accuracy (but *any* chloride would not do instead of salt for making hydrogen chloride, p 94). The main defect is a too strict adherence to the old-fashioned, cookery-book style, the pupil who believes all he is told in this book, and performs religiously the rites prescribed, will certainly learn much that is useful and interesting, but they will not help him to acquire or develop the scientific habit of mind, a possession of far greater value than a passive knowledge of the *minutiæ* of chemical change.

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University for the Years 1922 and 1923. Vol 16 47 papers, unpaged. (Cambridge, Mass.. Harvard University, n.d.) n.p

THIS volume covers a rather longer period than is indicated in its title, the earliest paper dating from February 1921 and the latest April 1924. Ten of them are by Prof. Bridgman, and deal with the properties of materials under high pressure, and several of these have been noticed in our columns Eleven others are due to G L. Clark, National Research Fellow, and Prof. W. Duane, and deal mainly with X-rays and their use in crystal analysis. In their method of investigating crystals the continuous spectrum of X-rays between 0·12 and $0{\cdot}89 \times 10^{-8}$ cm. is utilised, and this allows of the use of an ordinary X-ray tube with tungsten target run at a high voltage. The substance examined may be a single crystal or a powder. The wave-length of a ray which is reflected at a given angle from the material is calculated from the quantum equation $Ve\lambda = hc$, where V is the least voltage applied to the tube which will cause it to emit the line λ, e is the electronic charge, h Planck's constant, and c the velocity of light. The tube being run from a storage battery, V can be determined accurately. Prof. Lyman contributes three papers on a new vacuum spectrograph and the extreme ultra-violet spectrum.

The volume maintains the high standard established by its predecessors and shows that Harvard believes in extending as well as imparting knowledge.

Beach Grass. By C. W. Townsend. Pp. xii+319+42 plates. (Boston, Mass.: Marshall Jones Co., 1923.) 3.50 dollars.

THE reader who expects under this title to find a dissertation on *Psamma arenaria*, the marram grass of the coasts of the British Isles, will be disappointed, for the plant is scarcely mentioned. But the book is well worth reading. It is a breezy, refreshing account of many aspects of Nature on the sand-dunes that form the coast line in the neighbourhood of Ipswich, Essex Co., Massachusetts, U S A. The author is a naturalist in the widest sense of the word, and has here set down a number of observations, illustrated by some admirable photographs, that will interest alike the serious student of physical geology, the ornithologist, the forester, and indeed all whose scientific tastes take them into the open air. The description of the ice-bound sand-dune coast, and the effects of frost both on the shore and on the sea itself, and the bizarre scenery produced and most successfully illustrated, are truly wonderful In the chapters dealing with birds, biologists will find some shrewd remarks on sexual selection, and interesting accounts of the courtship of many species of birds Incidentally there are quoted authentic examples of the economic value of several birds of prey and of some of the insectivorous birds The book would perhaps be of more direct use to the British reader if the scientific names of the birds were inserted . the popular American names are not very familiar on the eastern side of the Atlantic

Reason and Morals: an Enquiry into the First Principles of Ethics By Dr Israel Levine. Pp xi+177. (Glasgow: MacLehose, Jackson and Co , London: Simpkin, Marshall and Co , Ltd , 1924) 6s net

THE author received the degree of D Litt from the University of Glasgow for this thesis, and though primarily dealing with a subject of philosophy, it is of peculiar scientific interest The moral law is generally held up to wonder and veneration as something utterly unintelligible on ordinary scientific principles, indicating a supernatural origin and bearing witness to a divine purpose in individual lives Dr. Levine, in a clear and trenchant argument, sweeps this whole conception away. The moral law is shown to be the simple condition on which human society can exist. Without morals common life is impossible, and without common life the survival of the human species is impossible The existence and maintenance of social life are the inevitable expression of the life-impulse itself. The essay concludes with a brief historical survey, in which it is claimed that the rational tradition in moral theory has received in modern times its complete vindication in the discoveries of psychology.

Die Grundgedanken der Machschen Philosophie: mit Erstveröffentlichungen aus seinen wissenschaftlichen Tagebuchern. Von Prof. Dr Hugo Dingler. Pp 106. (Leipzig . J. A. Barth, 1924) 3 gold marks.

AN excellent short account of the leading thought and ground-principle of the most philosophically minded of the German physicists When only fifteen, he had read from his father's library Kant's "Prolegomena" and Fechner's "Tagesansicht," and he seems even then to have formed a fixed resolution to eschew metaphysics and follow in all his researches a pure inductive method. He had throughout his life an almost English aversion to apriorism and to transcendental systems of philosophy. The book contains a most interesting selection from his note-books from 1880 to 1882 with memoranda for his "Mechanik." It recalls the "Common-place Book" of our own Berkeley.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Future of the Meteorological Office.

In the note on Mr C J P Cave's presidential address to the Royal Meteorological Society (NATURE, January 31, p. 168) Mr Cave is quoted as saying, "It is true that there is the Meteorological Office, but its position at the present time is an unfortunate one, its future is uncertain In the past the Meteorological Office was directly under the Meteorological Committee, which administered a Government grant. Soon after the War, the Office was placed under the Air Ministry It seems a grave anomaly that the Meteorological Office, which deals with problems of the greatest importance to many Government departments and to many public bodies, should be solely under the direction of the Air Ministry, more especially when there is in the Department of Scientific and Industrial Research a very suitable body under which it might have been placed"

Although I am sure Mr Cave would not wish this to be taken as anything more than his own personal opinion, I must ask you to allow me to say that I do not share it Far from the Meteorological Office being in an unfortunate position, it is fortunate in being able to command, under the Air Ministry, many facilities which no other Government department could give The well-organised wireless service of the Air Ministry, with its powerful station at Kidbrooke, is available for the exchange of those wireless messages on which national and international meteorology now depends. Aeroplanes are placed at our disposal to obtain observations from the upper air, and this would be quite impossible if we were not closely connected with the Royal Air Force and the Royal Aircraft Establishment at South Farnborough

I do not understand what Mr Cave means when he says "its future is uncertain." It is true that the Meteorological Committee formerly administered a Government grant, but that grant was only 20,000*l* before the War, while the meteorological expenditure now borne on Air Votes is more than 100,000*l* The Air Ministry necessarily exercises financial supervision over this expenditure, but I have no reason whatever to complain of the result In so far as the Treasury intervenes, this is an inevitable concomitant of the appropriation of money from public funds and is applicable to all voted services alike, whether administrative or scientific.

Flying, especially civil flying, is so dependent on a good meteorological service that if the Meteorological Office were not under the Air Ministry, there would have to be a separate meteorological service for aviation Only those who have had to organise the existing complicated meteorological service for aviation with its thirteen stations on aerodromes and hourly messages along the Croydon-Continental routes can realise the close connexion necessary between the Meteorological and other departments of the Air Ministry

Because the Meteorological Office deals with problems of the greatest importance to many Government departments and to many public bodies, the Meteorological Committee has been retained to advise the Air Council on matters relating to the Meteorological Office This Committee, on which there are representatives of the Royal Society, the Royal Society of Edinburgh and six Government departments, is by no means without influence on the policy of the Meteorological Office The Committee takes special interest in the scientific work of the Office, and one representative of the Royal Society is ex-officio vice-chairman This alone would be a guarantee that the scientific work is well maintained. As a matter of fact, we have more staff engaged on purely scientific work than ever before, and I am proud of the number of papers which are published yearly by my splendid scientific staff

After four years' experience as Director of the Meteorological Office under the Air Ministry, I am convinced that we could not do our work so well under any other department of Government, and I should be very sorry to have to return to a grant-in-aid

G C. SIMPSON

Meteorological Office,
Air Ministry,
Adastral House, Kingsway,
London, W C 2,
February 5

High Energy γ-Ray from Thorium Disintegration Products.

In the light of the standard measurements of the β-ray spectra of radium-B and -C by Ellis and Skinner (Roy Soc Proc, A, vol 105, p. 60, 1924) it was thought advisable to remeasure the spectra of thorium-B, -C, and -D This has been done, using the now well-known focussing method, and the results will be published in due course The purpose of this letter is to direct attention to two lines of high energy, namely, 2 55 and 2·62 million volts, with a possible third of slightly greater energy. The detection of these lines has been made possible by the preparation of thorium-B sources of greater strength than usual. There is no doubt of their existence, as they appear very clearly and sharply on the photographic plate. What is most remarkable is the fact that these lines correspond to the conversion of a γ-ray of energy 2·64 million volts in the K and L levels of an atom of atomic number 82 or 83, despite the fact that their energy is some twenty-eight times as great as that of the K level of an atom of that atomic number. This shows that the quantum relations hold for these high energy values in exactly the same way as they have been shown to do for the lower ones From an examination of the plates, it is seen that these lines lie beyond the region of the continuous background, and this fact may be of importance in atomic theories. Another point of interest is that there appear to be no lines between these and those of an energy of about 0 8 million volts D H. BLACK

Cavendish Laboratory, Cambridge,
January 17.

Touch and Sight *v.* The Microscope in Wool Classing and Sorting.

Not only do the fleeces from distinct breeds of sheep vary very considerably, but also, almost without exception, each individual fleece is made up of from three to seven or eight "qualities" of fibre

To the non-technical reader the term "quality" is something of a mystery, so it will be well clearly to define this term before proceeding further. This term has no reference to the "fibre-stuff," but refers principally to the fibre diameter. Thus, if q = quality number and d = fibre diameter in the fraction of an

inch, the following equations link up "quality" and "fibre diameter".

$$\text{Log. } a = \frac{1}{1\cdot6}(\log 1\,52 + \log d), \quad . \quad . \quad (1)$$

or

$$d = \frac{1}{1\,52\,q^{1\cdot6}} \quad . \quad . \quad . \quad (2)^1$$

Taking (1), with a 58's quality, the following result is obtained

58's quality = 1/1000 in diameter

Taking (2), with a fibre of 1/1000 in diameter the following result is obtained:

1/1000 = 58's quality

In List I the relationships between quality numbers 28's to 100's and fibre diameters are given

LIST I.—RELATIONSHIPS BETWEEN BRADFORD QUALITY NUMBERS AND FIBRE DIAMETERS IN FRACTIONS OF AN INCH

μ (1/1000 of m.m.)	Bradford Quality Number	Diameter Reciprocal by Formula
		in.
80·89	28's	314
65·30	32's	389
54·04	36's	470
42·69	40's	595
39·19	44's	648
36·50	46's	696
34·14	48's	744
31·95	50's	795
30·02	52's	846
28·25	54's	899
26·65	56's	953
25·23	58's	1007
23·86	60's	1064
21·52	64's	1180
19·54	68's	1299
18·66	70's	1361
15·06	80's	1686
12·48	90's	2034
10·54	100	2408

The connexion between the quality number and the fibre diameter is now quite evident, but the question at once arises as to what the quality number really represents

The quality number represents the number of hanks of 560 yards each to which one pound of the particular wool in question may be spun. Thus, 58's quality conveys to the spinner the information that

$$58 \times 560 = 32{,}480 \text{ yards}$$

may be spun from one pound of this wool. Thus, in a sense, the quality number represents the fineness of yarn (thread) which may be spun from any wool under consideration. In actual practice it is agreed that, broadly speaking, the quality number is rather greater than the corresponding length of thread. Thus, a 58's quality wool would not, as a rule, be spun to a count finer than 50's, that is:

$$50 \times 560 = 28{,}000 \text{ yards per lb}$$

Thousands of wool-classers[2] in Australia and elsewhere, and of sorters in Bradford and elsewhere, are daily classing or sorting fleeces of wool into the respective "qualities," and one or two interesting questions arise with reference to this work. In the first place, Is a sorter always consistent in his sorting? Does he always class the finer wool, say in a typical merino fleece, as 80's, the medium as 70's, and the coarse as 64's? And if he is found to be doing this according to the given equation to-day, did he make the same classification last year, and will he be making the same classification next year—say, as a test case, after six months away from the sorting table? More important still, will the wool-sorter in Bradford sort his fleeces into the same qualities that the Australian wool-classer would make, and will he be equally consistent in his sorting?

The writer has recently had the opportunity of carrying out certain classing and sorting tests in Australia, and later in Bradford, which, at least in part, answer these questions. On Bundure Sheep-station (New South Wales) the wool-classer was asked to select three typical qualities of wool, 68's, 64's, and 60's. Later, these were measured under the microscope, and upon these measurements the "frequency curves" shown in Fig. 1 were constructed and the "average diameters" of the three qualities of wools ascertained. It will be noted that the

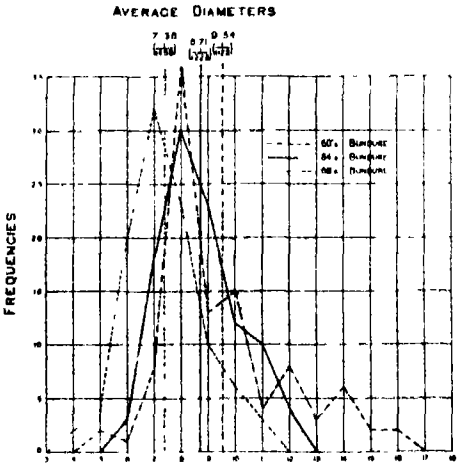


FIG. 1.—Bundure "Classings."

microscope almost exactly confirms the wool-classer's relative qualities, but that so far as coincidence with List 1. is concerned, the Australian wool-classer is almost a quality lower than the list.

Later, Camden Park (Sydney) merinos were submitted to a wool-sorter in Bradford, and he made of these wools three qualities, 80's, 70's, and 64's. Again, on the sorting being tested by the microscope, it is found that the sorter is quite consistent with his own qualities, the frequency curves being given in Fig. 2. On comparing Figs. 1 and 2, however, it is found that, following the microscopic measurements, approximately the same fibre diameter (1/1400 in.) is stated as 68's by the Australian wool-classer and as 80's by the Bradford wool-sorter. On comparing the 64's, however, it will be noted that the Australian wool-classer's 64's (Fig. 1) has a fibre diameter of 1/1122 in., while the Bradford wool-sorter's 64's (Fig. 2) has a diameter of 1/1311 in., *i.e.* finer than the Bundure 64's (1/1228 in.). Both are finer than would be expected from List I., and no doubt indicate that just as the temperature of the hand before estimating the temperature of a liquor may affect the estimate, so may touch and sight testing be affected by the exercising of these faculties just previous to the quality estimates in question.

These differences may further be explained as follows. The Bradford sorter is possibly sorting his wools into rather higher qualities than those prevailing in pre-War times. Again, the amount of "yolk"

[1] See "Woollen and Worsted Spinning," Wilkinson's Rule, p. 231 (Messrs. Cassell and Co.).

[2] "Classing" is the term applied to the estimation of the "quality" of the whole fleece, "sorting" is the term applied to the separation of the several qualities in one fleece.

(grease, etc) in the fibre varies with different wools, and in the case of these two wools was approximately:

Bundure . 50 per cent loss on scouring,
Camden Park . 60 per cent loss on scouring.

Thus, as the micro-measurements were made after clearing with ether and the classing or sorting carried out "in the grease," certain of the differences

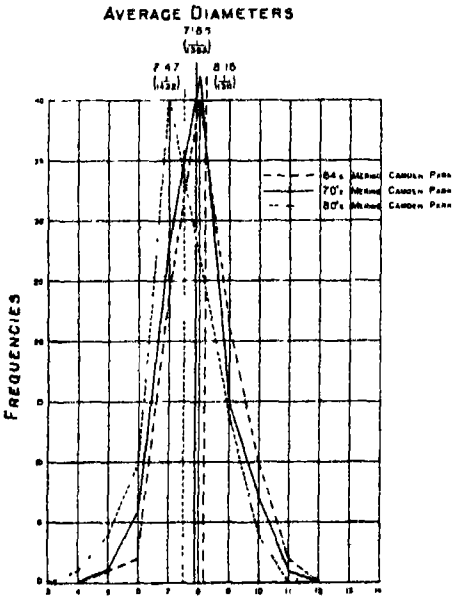


FIG. 2.—Bradford "Sortings."

observable may be explained. Broadly speaking, the following conclusions are to be drawn:

1. Wool-classers are very consistent in their "quality" estimations,

2. Wool-sorters are very consistent in their "quality" estimations,

3. Wool-classers as against wool-sorters and vice

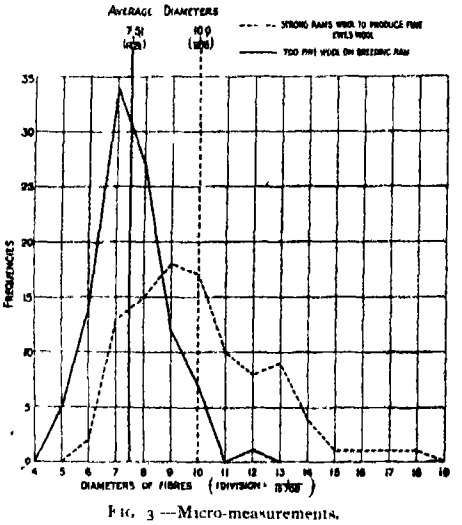


FIG. 3.—Micro-measurements.

versa are broadly consistent in their "quality" estimations,

4. Wool-classers in Australia as against wool-sorters in Bradford show small differences in their "quality" estimations—not always unimportant—when contrasted with one another;

5. Varying trade standards and varying conditions of the wools being classed or sorted affect the quality estimation;

6. Micro-metrical measurements may almost always be made under similar conditions, so that such "quality" estimations should be quite consistent;

7. Owing to the impossibility of examining more than a very few of the fibres under estimation (100 tests each in Figs. 1 and 2) the micro-metrical estimation is liable to give very erroneous results unless the test samples of fibres examined are very carefully selected and are truly representative of bulk.

It would thus appear that, under normal conditions, the work of the well-trained wool-classer or wool-sorter is trustworthy and that, broadly speaking, micro-metrical sorting will not be markedly better, and, if not carefully undertaken, may be worse.

An interesting case, however, arises when one wool happens to be, say, a 70's quality because the fibres are very consistently 1/1300 in. in diameter, and another wool is a 70's quality because many fibres above 1/1300 in. in diameter are balanced by others below even 1/1000 in. Such a case as this is partially in evidence in Fig. 3. Here are given the frequency curves for two wools specially selected by a noted Australian breeder as typical of a wool too fine (70's) and a wool about right (60's) for selected rams. The two curves reveal an astonishing difference in the "make-up" of the respective wool staples, of which the breeder was totally unconscious and which neither wool-classer nor wool-sorter would be likely to make note. It should also be noted that the narrow bases of the curves in Fig. 2 as against the broad base of at least one of the qualities in Fig. 1 might also tend to confuse the "classer" and the "sorter." Little has been done in such "correlating" as that treated here, but the subject is full of interest, and may prove to have most important bearings upon the selection of rams for breeding purposes both at home and in the Overseas Dominions. In the Textile Industries Department of the University of Leeds extensive ranges of typical Merino and British pedigree wools are being dealt with, and it is hoped that eventually (*a*) definite standards and (*b*) accepted methods of testing may be adopted throughout the wool industry both at home and abroad.

A. F. BARKER.

The University,
Leeds.

The Theory of Hearing.

IN NATURE, April 22, 1922 (vol. 109, p. 518), I pointed out that a series of clicks from a toothed wheel speeded up or down or by the voice is heard as a rising or falling tone and not as a noise or a jumble of tones. This fact contradicts the resonance theory of the mechanism of the cochlea.

The theory has now received a blow in the experiments of Dr. Harvey Fletcher at the Research Laboratories of the American Telephone and Telegraph Company and the Western Electric Company in New York (*Phys. Rev.*, 1924, xxiii., No. 3). The fundamental and a large number of harmonics can be eliminated from a compound tone without changing the pitch of the tone. A high-quality telephone system was used about which it was known that the sound coming out of the receiver was a faithful copy of that going into the transmitter. Electrical filters were introduced so that any tones could be eliminated. The character of the results was judged by three persons familiar with music, who agreed in every case. Typical experiments are the following:

Sound.	Pitch.	Eliminated components.	Eliminated frequencies.	Pitch change.	Quality change.
Voice *ah*	145	F	0 to 250	None	Inappreciable
		F+1 to 2	0 to 500	,,	Small.
		F+1 to 4	0 to 750	,,	Large
		F+1 to 7	0 to 1250	,,	Very large.
		F+1 to 9	0 to 1500	Uncertain	Noise
		6 to ∞	1000 to ∞	None	Small
		3 to ∞	500 to ∞	,,	Large.
		F −1 to 2 −6 to ∞	0 to 500		
			+1000 to ∞	,,	Very large.
Clarinet	259	F	0 to 500	,,	Large.
		F+1 to 2	0 to 1000	,,	Very large
		F+1 to 4	0 to 1500	,,	Non-musical.
		7 to ∞	2000 to ∞	,,	Large
		2 to ∞	750 to ∞	,,	Pure tone with no clarinet quality.

The work of Wegel and Lane (*Phys Rev.*, 1924, xxiii., No 2) and Fletcher (*Phys Rev.*, 1920, xv. 513) has shown that the hearing mechanism displays a non-linear response to external forces The character of the sensation when two tones are acting together on the ear varies considerably with the relative frequency and intensity values (Wegel and Lane) According to their dynamical theory, the vibrations pass along the basilar membrane and are shunted through narrow regions of the membrane at points depending on the frequency. The dynamic theory is simply a modified resonance theory.

Any resonance theory fails to explain Fletcher's experiments. When, for example, the fundamental is removed from a clarinet tone, there is no change in the pitch of the tone According to the resonance theory a sensation of tone corresponds to the vibration of a region of the fibres of the basilar membrane and vice versa. Here vast regions of the fibres may or may not vibrate without altering the sensation of pitch. The only change is one of quality Fletcher attempts to get around the difficulty by supposing that subjective tones—summation and difference tones—are introduced (!) mechanically in the cochlea into the stimulus that is sent to the brain For example, the presence of the tones 500 to ∞ in the clarinet experiment produces a sensation of a tone of the same fundamental pitch as 259 to ∞ with only a difference in quality, because these tones arouse the missing tones in the cochlea

This is a responsibility too heavy to be accepted on the basis of a hypothetical resonance analysis of the basilar membrane The responsibility becomes much less when the fibres of the membrane are regarded only as supporting and stiffening fibres not tuned to resonate. The result then becomes identical with my deformation theory reported in NATURE, April 26, 1924 (vol 113, p. 605) According to this theory, the basilar membrane alters the linear movement of the stapes into a change of form in three dimensions. Every external vibration produces a pattern deformation of the membrane. This pattern is communicated to the brain. A single vibration of a clarinet tone produces a definite pattern in three directions on the basilar membrane. The mental quality of the clarinet tone represents this pattern. When this vibration is repeated regularly, the clarinet quality appears to be based on a tone of definite pitch. Whether a tone of this pitch or of any other pitch is physically present in external vibrations or not, a fundamental will be heard as the loudest tone, the pitch of which is determined by the frequency of the repetitions.

Fletcher's experiments are an illustration of what occurs constantly in song. Many, perhaps most, vowels have no fundamental vibrations (NATURE, Jan. 13 and 20, 1921, pp. 632 and 664). They are produced by a series of isolated puffs which set the vocal cavities in vibration. Such vowels consist solely of higher tones than the one that is sung Yet, although the fundamental is lacking physically, it is heard as *the* tone of the voice. The physically non-existent tone is exactly the one—and the only one—indicated by the music. It is the tone intended to be sung, and is the one heard as a tone; the other tones—in this case all the tones that exist physically—are heard only as timbre or quality.

The work of Willis, Hermann, and myself on the vowels is now supplemented by the work at the New York laboratory All of it flatly contradicts the resonance theory. The simple facts of the accelerated toothed wheel and of portamento speech, however, ought to have been enough to convince any one. E W. SCRIPTURE.

University of Vienna.

The Ages and Masses of the Stars.

THE very interesting correspondence between Mr. Schumann and Dr Jeans in NATURE of January 24 has not touched on one of the most difficult questions, raised by the brilliant paper in which Dr. Jeans makes out such a strong case for extending our time-scale for the life of a star to some 10^{13} to 10^{14} years. The problem is simply how we are to account for the existence of uranium and thorium

As is well known, uranium has a half-life period of 6×10^9 years Therefore, even if the whole sun had consisted initially of uranium, there would barely be 2 kilograms left after 6×10^{11} years A great deal more than this exists on the earth alone Hence, either the life of the sun and earth must be much less than 6×10^{11} years or we must make the *ad hoc* assumption that uranium is being formed or at any rate prevented from disintegrating The temperature and pressure inside the sun are much too low to affect a reaction, the energy of which is so great as the energy of formation of radioactive substances.

A solution may be found if one admits the coalescence and annihilation of protons and electrons, for then, of course, radiation with quanta of energy $1{\cdot}66 \times 10^{-3}$ would be available. That this might photosynthesise uranium nuclei, though of course possible from purely energy considerations, scarcely seems plausible when one remembers that these complicated structures contain 238 protons and 146 electrons But it is not impossible that it might cause α-particles, which are presumably common in the interior of stars, to combine with lead and the heavier radioactive elements. On such a theory presumably the non-radioactive substances would be assumed to be built up in the same way

The basis of this explanation, however, the seductive hypothesis that protons and electrons may coalesce and be annihilated, is not without difficulties of its own The process in question presumably would occur when a proton and electron meet under certain peculiar conditions The frequency of such encounters must almost certainly depend upon the density and, to a less extent, on the temperature. The position would be much clarified if it could be shown from astronomical evidence that the evolution of energy per unit mass varied in the appropriate way with the density and temperature

These or similar speculations, which become inevitable if one accepts the extended time-scale, had therefore perhaps best be postponed until Dr. Jeans's theory has been further tested. They would be avoided, of course, if it could be shown that the loss of ordinary atomic mass under the influence of radiation pressure is much greater than the radiative mass emitted. It is difficult to make any convincing

estimate, but should it prove to be so it would immediately reduce our time-scale and relieve us of the necessity of entering upon speculations such as those touched on above

F. A LINDEMANN

Clarendon Laboratory,
University Museum, Oxford,
January 30

On the Hardness of Manganese Steel.

NOTWITHSTANDING its extraordinary importance, the discovery of the 13 per cent manganese steel, made by Sir Robert Hadfield more than forty years ago, has scarcely been elucidated regarding its most striking point, namely, the extremely high resistance to wear and tear, or the fact that the non-magnetic manganese steel, while comparatively soft in itself, offers an enormous resistance to a working tool

It is natural to assume that this resistance is to be explained in the following way.[1] The state of the iron in the manganese steel being that of the non-ferromagnetic γ-iron, stable at high temperature but unstable at ordinary temperatures, a mechanical stress is likely to cause the transformation into the ferromagnetic α-state, stable at low temperature This is in conformity with a general law of physical chemistry, exemplified by the well-known case of mercury iodide the yellow modification, persisting at ordinary temperature in an unstable condition, is transformed by mechanical stress into the red modification, stable at low temperature In other words the high resistance is explained by the assumption that mechanical work transforms the relatively soft Mn- austenite (γ-Fe) into martensite (α-Fe), known to be extremely hard From this view, if correct, it follows that mechanical work will at least partly transform the non-magnetic manganese steel into the ferromagnetic α-condition

Some time ago the correctness of this conclusion was tested at this Institute by Dr A. Westgren on a specimen, sent by Sir Robert Hadfield, of manganese steel which had been subjected to a tensile test

On X-ray analysis, however, no lines characteristic for α-Fe could be detected even in the contracted part of the specimen In view of this negative result, the following experiment, lately performed, seems to be of interest.

A small steel magnet needle (about 3 × 0·5 × 0·1 mm.) was fastened to one end of a thin silica fibre, so as to be suspended in a vertical position On approaching the sharp corner, or edge, of a Hadfield manganese (Era) steel specimen, it was not possible to obtain any sensible attraction of the needle—in conformity with its non-ferromagnetic character. On the other hand, a small drilling of the same steel (say 1·2 × 0·4 × 0·1 mm.) fixed at the end of a glass capillary, when brought near the needle, revealed a considerable attraction, or repulsion, proving the *drilling to be plainly ferromagnetic*, and thus even permanently. The objection being possible that the ferromagnetism might be caused by steel particles given off by the drill used, metallic shavings were obtained by using sharp quartz edges, and also a slow rotating alundum disc, in both cases the shavings were found to be distinctly ferromagnetic

Since it had been established in this way that the shavings have the magnetic characteristics of martensite, they were submitted to X-ray analysis by Dr. Westgren However, no lines of the α-state could be detected The reason probably lies in the fact that the α-lines are sharp only for a comparatively pure α-iron lattice, and rather blurred for the α-solid solutions, if in addition the α-portions occurring are few in number and very small, the analysis method developed as yet, is not sensitive enough to detect them. It may be considered as established that the difficulty in working non-magnetic manganese steel, is due, at least partly, to its partial transformation into martensite

CARL BENEDICKS.
(Director)

Metallographic Institute, Stockholm

[1] C Benedicks, "Hadfield's undersökningar över specialstål," *Teknisk Tidskrift*, Bergsvet, 1923, p 25.

A Stroboscopic Method of Determining Surface Tension of Liquids.

OF the various methods of determining surface tension of liquids, the method of ripples is free from all surface influences Lord Rayleigh, Dorsey, Grunmach, Kalähne and others have determined the surface tension of water by this method Grünmach applied the same method in determining the surface tension of some of the molten metals, but the main difficulty was that of observing the ripples properly to measure the wave lengths exactly, and the accurate estimation of the vibration frequency of the exciting fork Unless the stroboscopic arrangement is perfect, there is always an uncertainty in the determination



FIG. 1

of λ accurately, and as λ^3 is to be taken in the calculation, a slight variation in the value of λ affects the final value

We have, however, devised a method by which the stroboscopic arrangement is completely satisfactory. By fixing a fine edge to the prong of the exciting fork, and observing the reflection of this edge on the surface of the liquid at Brewster's angle (for water it is 53° 6′) fine teeth appear on the reflected image of the fine edge These teeth remain absolutely stationary so long as the vibrations of the fork remain constant The tips of the teeth are extremely sharp and stand a good deal of magnification (Fig. 1). The measurements of λ, therefore, could be made accurately The excitation is produced by a fine needle soldered to one end of this edge, the needle dipping only about 0·25 mm. below the liquid surface. The ripples are scarcely visible on the surface

The result given by this simple apparatus is satisfactory, namely, 74·1 in the case of clean distilled water The vibrations of the tuning-fork are also recorded along with a standardised seconds pendulum, so that the frequency can be ascertained with great accuracy up to the second place of decimals. A slight touch of grease at once increases λ considerably, as has been pointed out by Lord Rayleigh.

P. N. GHOSH.
D. BANERJI.

University College of Science,
Calcutta,
December 24.

The Permanence of Substance.

By Sir JOSEPH LARMOR, F.R.S.

IN Victorian times the atoms of matter were described by Clerk Maxwell, in picturesque and weighty phrase, as the "foundation stones of the material universe." It was believed that an æthereal medium for physical intercommunication in the cosmos was essential: and if so, material systems could not arise as other than mobile structures inhering in that universal medium. The standard illustration (for that was its true function) which went far by visual experiment to give vitality as well as precision to this general doctrine, was the Kelvin formulation of vortex atoms, based on Helmholtz's advances in the exact hydrodynamics of ideal perfect fluid, and lying in the natural succession to the brilliant but often fantastic gropings after vortical imagery by Descartes. The force of the illustration lay in the certainty that in the ideal pervading medium such vortex structures could not be wiped out, must be indestructible for ever. The ultimate atoms of matter, which stimulated the investigation of these vortical ring structures by way of analogy, have now been pushed back, first in theory and afterwards far more precisely by experimental discovery, to the electronic constituents of the chemical atoms.

If there is an æther, matter must be of necessity atomic, the possible variety of atoms being restricted to the limited number of types of suitable structure that are dynamically stable. and conversely, if matter is found to consist actually of self-contained atomic structures, this central fact is either evidence for a universal æther in which all matter subsists, or else must remain wholly inexplicable, perhaps even inscrutable. Such would be the modern version of the great argument of Democritus, on atoms and the void.

On the other hand, in extreme modern developments of the idea of relativity, the material universe seems to have no "foundation stones." An ultimate atom of matter is not there describable as an essential structure at all, such as can be explored, of course only partially, yet to an increasing degree which becomes adequate for more and more scientific purposes. It usually appears as nothing but a local aggregation of electric charge, held together by unknown internal constraint which is assumed not to disturb other relations. It can thus be liable to dissolve itself into pure motional energy by fusion with opposite charges; and the fact that the measures of mass and energy are modified in the same way by change of the frame of reference lends plausibility. The end of the cosmos would be the vanishing of matter: its beginnings must be on every scheme inscrutable.

It seems to be mainly with a view to elegance and completeness in the algebra that the electronic nucleus is thus introduced merely as a local aggregation of electric charge with some permanent law of volume-density. At a later stage it became recognised that internal forces are needed to hold it together; and whatever they may be they must not interfere with its necessary relativity as a whole as regards uniform translatory motion. They seem to be disposed of by being classed in the exposition as an unknown part of the stress-tensor of the field. Thus this procedure can be in no respect an improvement on the classical method which it claims to supersede, of regarding an electron as a structural singularity unknown except so far as it is defined by increasing knowledge of the field that is physically attached to it by its very constitution. Even in pure spatial analysis of differential geometry a singular pole is approached through the influence it sheds around the algebra never gets into the inside of it, so to say. That is the classical way, and can be held to be the correct scientific method, of approach to the properties of the unknown permanent electron or atom. The occasional denial of it seems possibly to be linked up with a metaphysical doctrine[1] that all natural law is nothing more than a manifestation of the *quasi*-geometric qualities of a fourway continuum named space-time, so that a complete exploration throughout it, by continuous spatial analysis without inherent unexplored poles, must be the aim of physical theory. The alternative view is that the infinitely little transcends human grasp by involving just as great inherent complexity as does the infinitely large, though both can be approached and annexed, with increasing completeness, to our scientific schemes, by virtue of transcendental relations of mind to matter which lie at the root of all possibility of knowledge or scientific formulations.

In further illustration of the contrast of methods, these hypothetical internal stress-forms the rôle of which is to hold a local distribution of electric density together, and so constitute an electron, may be more closely considered. They are now often referred to as the "forces of Poincaré," because he found out that for a shell model of the electron they can be formulated simply as an isotropic pressure, and without doing any violence to the relativity postulate for the structure. But, on the illustrative analogy of a rotational æther, it had been familiar that, for any static model, all that was required was to bring into play in the theory just this hydrostatic pressure that obviously can subsist in such an æther. Yet, viewed from this more concrete or physical point of view, that was not sufficient; for it was immediately recognisable that such a shell model is an unstable structure, much as is actually an electrified soap-bubble, thus requiring that analogies along that line had to remain in abeyance pending possible formulation of plausible slight constraints such as might protect the illustrative structure from destruction. But without assuming any definite internal structure for the electron at all—all such models are suggestive and valuable for consolidation of knowledge, none can be complete or final—we can postulate merely that it is permanent and is mobile, and explore, by mixed observation and theory, the nature of the field around it with continually increasing precision, and also the mutual influences of neighbouring electrons which arise from the superposition of their fields. This tentative procedure runs parallel to the course of actual progress: while any postulate of reduction of physical science to a self-contained

[1] An alternative form of the postulate, that nothing may be the subject of reasoning that cannot be observed, seems to imply a sense of humour.

geometric analysis in space-time may savour of reproducing the infinite with finite appliances.

It was already implicit in the Maxwellian æther-theory of half a century ago that a loss of energy δE from a material system, if it occurs by radiation, involves proportionate loss of inertial mass, of amount $\delta E/c^2$, where c is the speed of radiation: and vice versa. Such loss would have to fall on the internal relative potential and kinetic energies of the constituents of the radiating atom. There appears to be some astronomical knowledge now available, following on the lines of an idea recently introduced and explored by Dr Jeans (Monthly Notices R.A.S., November 1924, just now to hand), to estimate extreme superior limits restricting the amount and duration of radiation from the sun or a star that could be conceivable from this source of supply This new type of limit, doubtless, however, quite unapproachable, and uncertain as depending on an estimate of the internal mutual energies of the atom that may be available for running away into radiation, would stand in contrast, for example, with the famous historical estimate, enormously smaller, afforded by the running down into radiation of energy located outside the atoms, that of the mutual gravitation of the parts of the system in bulk; which was put forward in the early days of the conservation of energy by Kelvin and independently in more searching and complete manner by Helmholtz to explain the solar heat, but is now regarded on cogent grounds as inadequate for the facts of cosmic evolution when taken by itself.

Data are perhaps not entirely wanting for an estimate of the kind here described, along two ways of approach The total energy of relative positions and motions of electrons and other ultimate nuclei in the atom, such as might by the hypothesis possibly escape into energy of radiation, can on the lines of present general ideas of atomic structure be roughly set out. Indeed, the maximum possible transfer into radiant energy for all time would be measured by the total mutual energy of the initially disgregated elements, electrons and nuclei, that first fall into chemical atoms, of orbital type, and then ultimately on their destruction lapse together into closest contact. It is conceded that if atomic nuclei are regarded as finite electric charges concentrated almost into mere points, thus involving practically infinite space-density and so allowing the charges to approach infinitely near, this amount of possible radiation could tend to increase beyond measure. But that would introduce infinities in all directions, for example, infinite inertia of an atom, and is perhaps not contemplated on any kind of theory. (As the complete transformation, vice versa, of the gases from 1 c.c. of radium releases heat to the order of 10^7 calories, an easy computation shows that the preponderant nuclear energies of the atoms must there be very deeply drawn upon, as, of course, is now familiar, though not so much as to involve recognisable diminution of mass Cf. Rutherford and his coadjutors, as reported in his treatise.)

There seems to be another corroborating mode of approach, which must indeed be obvious; one which also affords some confirmation of our postulate of indestructibility of the primordial atoms. It lies in the cardinal discovery of Aston that the standard relative atomic masses of all the chemical elements are expressible in high approximation by integers, with only one challenging exception. When in the cosmic process two atoms are imagined to combine, forming an atom of a more complex kind of matter, there would thus be no room for much conversion of mass into energy: the mutual energy, residing in the local fields, that can become free to run away into radiation, must correspond to the equivalent of a very small portion, perhaps on the experimental results not more than one-tenth per cent, of the total mass, however intimate be the consolidation that is required into one central nucleus for the new atom

For astronomical purposes Dr Jeans has made an estimate of the course of evolution for the universe, if all the matter in it were classed as a form of energy convertible into radiation. He finds, on Eddington's hypotheses, that durations of the present cosmic order ranging around two hundred millions of millions of years would become conceivable Perhaps if only the mutual positional and motional energies of the ultimate discrete constituents of atoms could at the very most run into radiation, the energy thus assumed to be available (which is no measure of the duration of the system) must be reduced on the first estimate above by a factor which might be as small as 10^{-8} or as great as 10^{-5}, and on the other by a factor which could not exceed 10^{-3}

Apart from such interesting change in formulation of an ultimate cosmic problem, the object of the present discussion is to concentrate on one fundamental question, which has become conspicuous in much recent ultra-physical speculation. Is matter to be regarded as consisting irrevocably of primordial atomic structures absolutely permanent: or alternatively, discarding all structural analogies based on classical dynamical principles, are the atoms, if such then really are retained, to be considered as mere concretions or aggregations liable to dissipate entirely into energy of radiation and so vanish?

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

7. OSBORNE REYNOLDS (1842–1912).

WHENEVER I hear of a man who is described as being lovable, the figure of Osborne Reynolds rises up before me; and yet I doubt whether on a casual acquaintance or in official intercourse that adjective would have suggested itself. In ordinary conversation he often took a cynical view of things; he was obstinate in adhering to his own opinion, absolutely uncompromising, and sometimes a little hasty in imputing selfish motives to his opponents. But the discordant elements of his character were fused together by an almost primitive simplicity of mind, and after closer acquaintance few could resist the charm of his strong personality.

His loyalty to friends and colleagues knew no bounds.

[1] Continued from p. 199.

In 1883, Mr. E. J. Stone, formerly Astronomer Royal at the Cape of Good Hope and—at the time—president of the Royal Astronomical Society, made a series of communications to the Society in which he claimed to show that the discrepancies between the lunar tables and the observed position of the moon had no reality, but were only natural consequences of the changes which had, from time to time, been introduced in the adopted mean solar day, and in particular, that the errors of Hansen's tables of the moon were due to the adoption of Leverrier's solar tables by the British Nautical Almanac. The matter was of the highest importance, as it affected our fundamental unit of time. The subject is intricate and full of pitfalls, but clear-headed men like Adams, Cayley, and Newcomb all came to the conclusion that Stone's assertion could not be maintained. I must have mentioned the matter to Osborne Reynolds. He had no special interest in astronomy; in fact, he knew very little about it, but he had been a fellow of Queen's College, Cambridge. So had Stone, and that was sufficient reason why Stone should be right. When I quoted Cayley and Adams it made no impression. Reynolds maintained the general thesis that when a man of established reputation has the whole scientific world against him, it is quite certain that the man who stands alone is right. After considering the subject for a few days he came to me and said: "I have gone into the question, and I remain convinced that Stone is right." Again two days later he expressed the same opinion. Another week passed and he recanted, admitting that Stone was wrong. But he had spent more than a week on a new, and probably uncongenial, subject in the forlorn hope of being able to support a friend.

An interesting chapter in the history of science could be written on the hampering effect of knowledge that is either deficient or too complete. Ignorance may lead astray, but perfect knowledge often acts as a brake and stops the car when a reckless spurt would take the driver into new territory. For the moment I am thinking of the early history of the radiometer, though this is not perhaps the best example that could be chosen. The manner in which Crookes was led from certain irregularities of weighing to the construction of his interesting little instrument was wholly admirable, and some of the steps in the research, such as the improvement of air-pumps, marked considerable advances, while other incidental results are of permanent value. But it is permissible to ask whether any one wholly conversant with the property of gases at low pressures, and therefore able to anticipate the effect discovered by Crookes, would have taken all the trouble to spend two years in demonstrating it. Even if familiar with Maxwell's radiation pressure, perfect knowledge would have recognised that there was no immediate hope of verifying it experimentally until the methods of obtaining high vacua were improved to a degree not dreamt of in those days.

There can be no doubt that the driving power of Crookes's work was the hope of discovering a new property of radiation. The first communication read before the Royal Society in December 1873 concludes with the following statement: "In the radiant molecular energy of cosmical masses may at last be found that 'agent acting constantly according to certain laws,' which Newton held to be the cause of gravity." He modified his views later, and ascribed the effect to light "even where there is no heat" (NATURE, Vol. 12, p. 124).

Reynolds recognised that the apparent repulsion could be explained without the help of unknown forces in the belief, at first, that they were due to condensed moisture evaporating under the influence of thermal radiation; but he soon replaced this view by the now generally accepted theory. Johnstone Stoney had put forward similar ideas which, nevertheless, differed in essential points.

During the winter of 1873–74 I suggested to Reynolds, as I had done to others, that the main question whether the repulsion was caused by internal or external forces could be solved in a very simple manner, by the reaction on the containing vessel. When I returned in November 1875 from the Siamese eclipse, I found controversies still raging, but no one had taken the trouble to try the crucial experiment. I was reluctant to do so myself, as a number of persons were working on the subject, and I have perhaps an exaggerated objection to cutting into what I consider to be other people's work. I repeatedly spoke to Reynolds about it in the hope that he would take the matter up. One evening after lecturing hours, while I was working alone in the Physical Laboratory, Osborne Reynolds entered the room and said: "I want you to do that experiment you spoke of, and to do it now. I have got everything ready for you." I went with him to the lecture room. We suspended the radiometer with an attached mirror, and, at the first trial, it behaved as it should. The vessel swung round as soon as the light fell on the blackened surfaces, and returned to its position of rest when the rotation of the vanes had reached the steady state. Reynolds would not listen to the proposal of a joint communication, and my paper appeared in due course in the Philosophical Transactions.

In his writings, as in his speech, Reynolds was difficult to understand. His brain seemed to work along lines different from those of the majority of us. He looked upon all things in an original manner, and the education of his children was one of them. I once found him playing with his little son, and nothing seemed to give him greater pleasure than when the boy did the opposite thing to that which he was asked to do. "Come here," said Reynolds, and when the child went further away Reynolds was delighted, interpreting the act as showing independence of spirit. The incident made a great impression on me.

In his later years Reynolds had difficulty in finding the right word, using sometimes one that had the opposite meaning to that required. This failing ultimately developed into a regular aphasia.

The value of his scientific work is admirably described in the obituary notice published by the Royal Society. It may be added that though his theory of the construction of the universe, on which he concentrated his whole strength at the end of his scientific life, received little support, it may yet find its place in reconciling the old and new physics.

In his lectures Reynolds was often carried away by his subject and got into difficulties. Some humorous incidents are related with regard to the manner in which he got out of them. He was once explaining the slide

rule to his class; holding one in his hand, he expounded in detail the steps necessary to perform a multiplication. "We take as a simple example three times four," he said, and after appropriate explanations he continued, "Now we arrive at the result; three times four is 11·8." The class smiled. "That is near enough for our purpose," said Reynolds It may be imagined that the average student was often puzzled; but nevertheless, the number of scientific engineers of high standing that he trained is a testimony to his teaching power, when he had the right material with which to deal. That power was not one of imparting knowledge but rather of stimulating thought.

Not long ago a representative of the University of Manchester lectured in the United States. At the conclusion of the lecture a gentleman stepped out from the audience, and addressing the lecturer, said: "I understand that you come from Manchester. I owe all my success in life to Osborne Reynolds, and I ask you to accept a cheque for the benefit of the University as a sign of gratitude" No one could wish for a higher testimonial than that

The Fossil Anthropoid Ape from Taungs.

By Sir ARTHUR KEITH, F.R.S

THE discovery of fossil remains of a "man ape" in South Africa raises many points of great interest for those who are studying the evolution of man and of man-like apes No doubt when Prof. Dart publishes his full monograph of his discovery, he will settle many points which are now left open, but from the facts he has given us, and particularly from the accurate drawing of the endocranial cast and skull in profile, it is even now possible for an onlooker to assess the importance of his discovery I found it easy to enlarge the profile drawing just mentioned to natural size and to compare it with corresponding drawings of the skulls of children and of young apes. When this is done, the peculiarities of Australopithecus become very manifest

Prof Dart regrets he has not access to literature which gives the data for gauging the age of young anthropoids In the specimen he has discovered and described, the first permanent molar teeth are coming into use Data which I collected 25 years ago show that these teeth reach this stage near the end of the 4th year, two years earlier than is the rule in man and two years later than is the rule in the higher monkeys In evolution towards a human form there is a tendency to prolong the periods of growth Man and the gorilla have approximately the same size of brain at birth, the rapid growth of man's brain continues to the end of the 4th year; in the gorilla rapid growth ceases soon after birth

Prof Dart recognises the many points of similarity which link Australopithecus to the great anthropoid apes—particularly to the chimpanzee and gorilla. Those who are familiar with the facial characters of the immature gorilla and of the chimpanzee will recognise a blend of the two in the face of Australopithecus, and yet in certain points it differs from both, particularly in the small size of its jaws.

In size of brain this new form is not human but anthropoid In the 4th year a child has reached 81 per cent. of the total size of its brain; at the same period a young gorilla has obtained 85 per cent. of its full size, a chimpanzee 87 per cent. From Prof Dart's accurate diagrams one estimates the brain length to have been 118 mm.—a dimension common in the brains of adult and also juvenile gorillas The height of the brain above the ear-holes also corresponds in both Australopithecus and the gorilla—about 70 mm. But in width, as Prof. Dart has noted, the gorilla greatly exceeds the new anthropoid; in the gorilla the width of brain is usually about 100 mm., in Australopithecus the width is estimated at 84 mm. The average volume of the interior of gorillas' skulls (males and females) is 470 c.c., but occasional individuals run up to 620 c.c. One may safely infer that the volume of the brain in the juvenile Australopithecus described by Prof. Dart must be less than 450 c.c., and if we allow a 15 per cent. increase for the remaining stages of growth, the size of the adult brain will not exceed 520 c.c. At the utmost the volume of brain in this new anthropoid falls short of the gorilla maximum. Even if it be admitted, however, that Australopithecus is an anthropoid ape, it is a very remarkable one. It is a true long-headed or dolichocephalic anthropoid—the first so far known. In all living anthropoids the width of the brain is 82 per cent. or more of its length, they are round-brained or brachycephalic, but in Australopithecus the width is only 71 per cent. of the length. Here, then, we find amongst anthropoid apes, as among human races, a tendency to roundness of brain in some and to length in others. On this remarkable quality of Australopithecus Prof. Dart has laid due emphasis

This side-to-side compression of the head taken in conjunction with the small size of jaws throw a side light on the essential features of Australopithecus. The jaws are considerably smaller than those of a chimpanzee of a corresponding age, and much smaller than those of a young gorilla There is a tendency to preserve infantile characters, a tendency which has had much to do with the shaping of man from an anthropoid stage The relatively high vault of the skull of Australopithecus and its narrow base may also be interpreted as infantile characters. It is not clearly enough recognised that the anthropoid and human skulls undergo remarkable growth changes leading to a great widening of the base and a lowering or flattening of the roof of the skull. In Australopithecus there is a tendency to preserve the fœtal form.

When Prof Dart produces his evidence in full he may convert those who, like myself, doubt the advisability of creating a new family for the reception of this new form. It may be that Australopithecus does turn out to be "intermediate between living anthropoids and man," but on the evidence now produced one is inclined to place Australopithecus in the same group or sub-family as the chimpanzee and gorilla. It is an allied genus. It seems to be near akin to both, differing from them in shape of head and brain and in a tendency to the retention of infantile characters. The geological evidence will help to settle its relation-

ships. One must suppose we are dealing with fossil remains which have become embedded in the stalagmite of a filled-up cave or fissure of the limestone cliff.

May I, in conclusion, thank Prof. Dart for his full and clear description, and particularly for his accurate drawings. One wishes that discoverers of such precious relics would follow his example, and, in place of reproducing crude tracings and photographs, give the same kind of drawings as an engineer or an architect prepares when describing a new engine or a new building

By Prof G. ELLIOT SMITH, F R S

IT is a great tribute to Prof. Dart's energy and insight to have discovered the only fossilised anthropoid ape so far obtained from Africa, excepting only the jaw of the diminutive Oligocene Propliopithecus from the Egyptian Fayum. Whether or not the interpretation of the wider significance he has claimed for the fossil should be corroborated in the light of further information and investigation, the fact remains that his discovery is of peculiar interest and importance.

The simian infant discovered by him is an unmistakable anthropoid ape that seems to be much on the same grade of development as the gorilla and the chimpanzee without being identical with either. So far Prof Dart does not seem to have "developed" the specimen far enough to expose the crowns of the teeth and so obtain the kind of evidence which in the past has provided most of our information for the identification of the extinct anthropoids Until this has been done and critical comparisons have been made with the remains of Dryopithecus and Sivapithecus, the two extinct anthropoids that approach nearest to the line of man's ancestry, it would be rash to push the claim in support of the South African anthropoid's nearer kinship with man Prof. Dart is probably justified in creating a new species and even a new genus for his interesting fossil: for if such wide divergences between the newly discovered anthropoid and the living African anthropoids are recognisable in an infant, probably not more than four years of age, the differences in the adults would surely be of a magnitude to warrant the institution of a generic distinction.

Many of the features cited by Prof Dart as evidence of human affinities, especially the features of the jaw and teeth mentioned by him, are not unknown in the young of the giant anthropoids and even in the adult gibbon.

The most interesting, and perhaps significant, distinctive features are presented by the natural endocranial cast They may possibly justify the claim that Australopithecus has really advanced a stage further in the direction of the human status than any other ape. But until Prof. Dart provides us with fuller information and full-size photographs revealing the details of the object, one is not justified in drawing any final conclusions as to the significance of the evidence.

The size of the brain affords very definite evidence that the fossil is an anthropoid on much the same plane as the gorilla and the chimpanzee. But while its brain is not so large as the big gorilla-cast used for comparison by Prof. Dart, it is obvious that it is bigger than a chimpanzee's brain and probably well above the average for the gorilla. But the fossil is an imperfectly developed child, whose brain would probably have increased in volume to the extent of a fifth had it attained the adult status. Hence it is probable the brain would have exceeded in bulk the biggest recorded cranial capacity for an anthropoid ape, about 650 c c. As the most ancient and primitive human brain case, that of Pithecanthropus, is at least 900 c c. in capacity, one might regard even a small advance on 650 c.c. as a definite approach to the human status The most suggestive feature (in Prof Dart's Fig. 5, p 197) is the position of the sulcus lunatus and the extent of the parietal expansion that has pushed asunder the lunate and parallel sulci—a very characteristic human feature.

When fuller information regarding the brain is forthcoming—and no one is more competent than Prof Dart to observe the evidence and interpret it—I for one shall be quite prepared to admit that an ape has been found the brain of which points the way to the emergence of the distinctive brain and mind of mankind Africa will then have purveyed one more surprise—but only a real surprise to those who do not know their Charles Darwin But what above all we want Prof Dart to tell us is the geological evidence of age, the exact conditions under which the fossil was found, and the exact form of the teeth.

By Sir ARTHUR SMITH WOODWARD, F.R S

THE new fossil from Taungs is of special interest as being the first-discovered skull of an extinct anthropoid ape, and Prof Dart is to be congratulated on his lucid and suggestive preliminary description of the specimen As usual, however, there are serious defects in the material for discussion, and before the published first impressions can be confirmed, more examples of the same skull are needed

First, as Prof. Dart remarks, the fossil belongs to an immature individual with the milk-dentition, and, so far as can be judged from the photograph, I see nothing in the orbits, nasal bones, and canine teeth definitely nearer to the human condition than the corresponding parts of the skull of a modern young chimpanzee The face seems to be relatively short, but the lower jaw of the Miocene Dryopithecus has already shown that this must have been one of the characters of the ancestral apes The symphysis of the lower jaw may owe its shape and the absence of the "simian shelf" merely to immaturity; but it may be noted that a nearly similar symphysis has been described in an adult Dryopithecus, of which it may also be said that "the anterior symphyseal surface is scarcely less vertical than that of Heidelberg man" (see diagrams in Quart. Journ. Geol Soc., vol 70, 1914, pp 317, 319)

Secondly, the Taungs skull lacks the bones of the brain-case, so that the amount and direction of distortion of the specimen cannot be determined. I should therefore hesitate to attach much importance to rounding or flattening of any part of the brain-cast, and would even doubt whether the relative dimensions of the cast of the cerebellum can be relied on. Confirmatory evidence is needed of the reality of appearances in such a fossil.

In the absence of knowledge of the skulls of the fossil anthropoid apes represented by teeth and fragmentary jaws in the Tertiary formations of India, it is premature to express any opinion as to whether the direct

ancestors of man are to be sought in Asia or in Africa. The new fossil from South Africa certainly has little bearing on the question.

Palæontologists will await with interest Prof. Dart's detailed account of the new anthropoid, but cannot fail to regret that he has chosen for it so barbarous (Latin-Greek) a name as Australopithecus.

By Dr W. L. H. DUCKWORTH.

PROF. DART'S description of the fossil skull found at Taungs in Bechuanaland shows that this specimen possesses exceptional interest and importance. Should the claims made on its behalf prove good, then its discovery will in effect be comparable to those of the Pithecanthropus remains, of the Mauer mandible and the Piltdown fragments. In the following paragraphs I venture to make some comments based upon perusal of the article published in NATURE of February 7.

First of all, the fact that the fragments came immediately under notice of so competent an anatomist as Prof. Dart establishes confidence in the thoroughness of the scrutiny to which they have been subjected That the history of the specimen should be known precisely from the time of its release from the limestone matrix, provides another cause for satisfaction.

The specimen itself at once raises a number of questions, and, as Prof Dart evidently realises, these fall into at least two categories. The first question arising out of the discovery is the status of the individual represented by these remains. But the answer to that question, and the presence of such a creature in South Africa, affect other problems. The latter include inquiry into the probable locality of origin of the simian and human types, and the search for evidence of dispersion from a centre, or along a line of successive migrations

In dealing with the first problem, Prof. Dart has surveyed a considerable number of structural details, and he concludes that the specimen represents an extinct race of apes intermediate between living anthropoid apes and mankind. The specimen comprises the greater part of a skull with the lower jaw still in place (or nearly so) The number and characters of the teeth testify to the immaturity of the individual. The evidence on the last-mentioned point is quite definite, and interest thus comes to be centred in the status assigned to the specimen, namely, that of a form intermediate between the living anthropoid apes and man himself.

Prof Dart places the specimen on the side of the living anthropoid apes in relation to the interval separating these from man At the same time, it is claimed that this new form of ape is more man-like than any of the existing varieties of anthropoid apes; and so it comes about that the decision turns on the claims made for the superiority of the new ape to these other forms.

The report shows that (as noted above) many structural details have been scrutinised, and that all accessible parts of the specimen have been examined. The observations relate not only to the external parts of the skull and lower jaw, but also to the endocranial parts exposed to view by the partial shattering of the brain-case. The claims advanced on behalf of the higher status of the specimen are based, therefore, upon a number and variety of such details. Should Prof. Dart succeed in justifying these claims, the status he proposes for the new ape-form should be conceded. Much will depend on the interpretation of the features exhibited by the surface of the brain, as also upon that of all the characters connected therewith, and since Prof. Dart is so well equipped for that aspect of the inquiry, his conclusions must needs carry special weight there. In regard to the brain and its characters, I find the tracing of the contour of an endocranial cast in a gorilla-skull shown in Fig. 6 rather surprisingly flattened, and almost suggestive of the influence of age.

Among the anatomical characters enumerated in the article, some appear to me to possess a higher value in evidence than others. As good points in favour of the claims, there may be cited, in addition to the cerebral features to which reference has just been made, the level of the lower border of the nasal bones in relation to the lower orbital margins, the (small) length of the nasal bones, the lack of brow-ridges (even though the first permanent tooth has appeared fully), the steeply-rising forehead, and the relatively short canine teeth

On the other hand, I feel fairly certain that some of the other characters mentioned are related preponderantly to the youthfulness of the specimen. Fully to appreciate the latter, demands not only the handling of it, but also thorough survey of a collection of immature (anthropoid ape) crania. The development of the "shelf" at the back of the symphysis of the lower jaw may almost certainly be delayed in some individuals (gorillas) Even the level of the lower border of the nasal bones is subject to some variation, and in young gorillas before the first permanent tooth has emerged fully, that level may be (as in man) above the level of the orbital margin. Generally, the elimination and detachment of features influenced largely by the factor of age demand special attention.

If, however, the good points can be justified, then these characters of youth will not gravely affect the final decision.

However these discussions may end, the record remains of the occurrence of an anthropoid ape some two thousand miles to the south of the nearest region providing a record of their presence. So far as the illustrations allow one to judge, the new form resembles the gorilla rather than the chimpanzee, that is, an African, not an Asiatic form of anthropoid ape. In this respect the new ape does not introduce an obviously disturbing factor. Disturbance, and the re-casting of disturbed views, might nevertheless be caused in two other directions. Thus, the determination of the geological antiquity of the embedding of the fossil remains might have such an effect, were the estimate such as to carry that event very far back in time. Again, a comparison of the new ape with the fossil forms from India (Siwaliks) remains to be made, and it may be productive of results bearing on the relation of the African and the Asiatic groups. In any case, opinion must needs conform to the situation created by this discovery.

If in these notes there have been passed over those observations and reflections wherewith Prof. Dart has illustrated and supported his views, such omissions are not due to want of appreciation, but to lack of capacity and space for their adequate treatment.

Obituary.

MR. OLIVER HEAVISIDE, F.R.S.

BY the death of Oliver Heaviside the scientific world loses one of its most original thinkers. He was born in London on May 13, 1850, and his uncle was Sir Charles Wheatstone, the practical founder of modern telegraphy. The Heaviside family were interested in music and telegraphy His brother Charles, who lived at Torquay, was connected with the musical industry, and his brother, Arthur West Heaviside, was a superintending engineer to the Post Office and one of the pioneers of radio telegraphy.

After leaving school Heaviside obtained a post with the Great Northern Telegraph Co. at Newcastle-on-Tyne, which he held for several years. During this period he communicated papers to the *English Mechanic*, the *Telegraphic Journal* and the *Philosophical Magazine* These papers are of more than average ability and show great promise For example, in 1873 he showed that quadruplex telegraphy was a possibility. Unfortunately, in 1874, increasing deafness made him retire from business life and he went to live in Devon. He now devoted himself whole-heartedly to the study of electricity and its applications. He published many papers which gradually became more and more technical and more and more difficult to understand, as it became necessary, in order to avoid repetition, to assume that the reader knew some of the writer's previous work. Consequently he had difficulty in getting them published in the ordinary technical journals. At that period there were few referees competent to understand them. As a rule they suggested that the paper should be cut down. The result was that many necessary mathematical links were left out, and the expert has no easy task to follow the reasoning. Fortunately, several well-known scientific men—in particular Sir Oliver Lodge, Prof. Perry, and Dr. G. F. C. Searle—had noted the advent of a mathematical physicist of superior ability and helped him to get his papers published. He had, however, to run the gauntlet of a good deal of unintelligent criticism, and none of his discoveries received that immediate recognition which their merit deserved.

Heaviside communicated to the Society of Telegraph Engineers (now the Institution of Electrical Engineers) a paper solving the problem of the electrostatic and electromagnetic interference between overhead parallel wires, a problem which has come to the front at the present time. His methods of measuring mutual inductance published in 1887 are of great value in themselves, and, like most of Heaviside's work, have been most fruitful in suggesting extensions to others. He was the first to solve the problem of the high-frequency resistance and inductance of a concentric main. It would probably have remained neglected for many years had not Kelvin given some of his results in his presidential address to the Institution of Electrical Engineers in 1889.

From the practical point of view, Heaviside's most important work was laying the foundation of the modern theory of telephonic transmission; a theory which has proved a veritable gold mine for the practical telephonist. He pointed out that the difficulties which arose in telephony were due to the different attenuations and different velocities of the various component waves which carry the necessary currents His theory of the distortionless circuit showed clearly the lines on which telephony could be developed Working on these lines some ten years later, Prof Michael Pupin in the United States developed his loading coils, and long-distance telephony was born.

In 1891 Heaviside was elected a fellow of the Royal Society In 1892 his earlier "Electrical Papers" were published in two volumes The value of his work began then to be realised by electricians He did perhaps more than any man to show the value of a knowledge of physics and of mathematical theory in the electrical industry. Pupin has said that Heaviside did much "to introduce the living language of physics in place of the sign language of mathematical analysis" Heaviside's pioneering work will always take a leading place in the history of electrical theory

The first volume of Heaviside's great work on "Electromagnetic Theory" was published in 1893 and the second volume in 1899 His original intention was to publish the third volume in 1904 and the concluding volume in 1910, but this he found impossible, and so published the third and concluding volume in 1912.

Heaviside was the first to give the theory of the steady rectilinear motion of an electron through the ether, a theory which has been developed by others—notably by Searle—with important results By an electron he simply meant an electric charge He pointed out many years ago that even if we knew the constitution of the electron we would be a long way from finality There is no absolute scale of size in the universe As it is boundless in one way towards the great, it is equally boundless towards the small He was one of the first to predict the increase of mass of a moving charge when its speed becomes very great To verify all Heaviside's reasoning and especially to examine the validity of some of his mathematical methods will provide work for many mathematicians and physicists. He strongly resented the contemptuous tone adopted by some mathematicians when referring to his work on divergent and semi-convergent series. He had found them useful in general theory and for computing purposes, and so he naturally considered his critics prejudiced. In June 1902 he wrote the article on the "Theory of the Electric Telegraph" in the "Encyclopædia Britannica." Many theorems given in this article are constantly quoted by the writers of text-books. In particular his description of what is now called the Heaviside layer, by means of which Hertzian waves are supposed to be bent round the earth, is familiar to every radio engineer

In the later years of his life Heaviside was one whom every electrical engineer delighted to honour In 1908 he was elected an honorary member of the Institution of Electrical Engineers. When in 1921 the Faraday Medal was founded, it was universally considered most appropriate that Heaviside should be the first Faraday medallist. The president, Mr. J. S. Highfield, went to Torquay and presented it to him in person He was an honorary Ph.D. of Göttingen, an honorary member of the Literary and Philosophical Society of Manchester and of the American Academy of Arts and Sciences.

For fifty years Heaviside lived practically a hermit's life at Torquay. He was a good correspondent, but very difficult to approach personally In his later years Dr. and Mrs. Searle of Cambridge were practically his only friends The Government gave him a civil list pension, and about twenty years ago Mr Asquith increased it The Institution of Electrical Engineers took a filial interest in him, and it is gratifying to remember that during the last few years of his life the Institution kept in constant touch with him. In the preface to his "Electrical Papers" he says that the question "Will it pay?" never interested him He was, he said, mainly actuated by philanthropic motives Looking back—as he has probably saved the Government of every large civilised country in the world millions of pounds in the costs of their telephone schemes—he was truly a philanthropist He died at Torquay on Tuesday, February 3, and was buried on Friday, February 6, in the same grave as his father and mother, only relatives and Mr R H. Tree, representing the Institution of Electrical Engineers, being present Thus ended the life of one who has left a record of work which has proved of great value to the world.

A. RUSSELL.

PROF N. KULCHITSKY.

THE death of Prof Nicholas Kulchitsky on January 30, at the age of sixty-nine, has removed one of the foremost of Russian histologists. For many years he occupied the chair of histology at the University of Charkov, where he accomplished most of his researches His methods of fixing and staining tissues are now in universal use—those for smooth muscle are particularly well known. He devoted much attention and made numerous important observations on the distribution of connective tissue in the intestinal tract and other organs His text-books of histology are standard works and at present are commonly used by Russian medical students. That his work was well known outside his own country is shown by the fact that he was an honorary member of the Anatomical Society of Great Britain and Ireland.

Prof. Kulchitsky was a man of wide interests and sympathies. He responded whole-heartedly to the request of his government for his expert assistance in the work of the Ministry of Education, and for a number of years he held the post of administrator of education in the Charkov district and later in the Petrograd district During the period just before the first revolution he held the post of Minister of Education During the period of upheaval he suffered severely from the hardships attending revolution and counter-revolution. In order to maintain his family and himself he was reduced to hard manual labour. That he was able to live through these hardships, at his advanced age, is evidence of his characteristic power for hard work and perseverance At length he was fortunate enough to embark on a British refugee ship together with remnants of Wrangel's forces, and this brought him to London, where he found shelter and opportunities for continuing his scientific endeavours.

During the brief time of less than three years, as lecturer in the Department of Histology at University College, London, Kulchitsky was largely concerned with the teaching of students, but he also completed several important and significant researches. Not the least of these is that in which he showed that voluntary muscles are supplied by both medullated and sympathetic nerve fibres, the former being attached to the large muscle fibres, whilst the latter supply small muscle fibres These facts led to the physiological and clinical investigations of the late Prof. Hunter, who showed that the smaller fibres are responsible for the maintenance of tone in voluntary muscles. The work has found important applications in the operation of dividing the sympathetic nerves supplying the muscles affected in cases of spastic paraplegia

Prof Kulchitsky and Prof. J. I. Hunter were associated in their work, and it is indeed a sad coincidence that the untimely death of young Prof. Hunter should so soon have been followed by the unfortunate accident, a fall down an elevator shaft at University College, which led to the death of Prof. Kulchitsky

The loss of Prof. Kulchitsky is deeply mourned by all his associates and friends at University College and by the scientific world in general G. V A.

DR. DAVID B. SPOONER

THE Archæological Department of the Indian Government has suffered a heavy loss by the death at Agra on January 30 of Dr. David B. Spooner, who had been Deputy Director-General of Archæology in India since 1919 and had acted on one occasion as head of the Survey during Sir John Marshall's absence on leave. Dr. Spooner's connexion with the Department commenced at the opening of the present century, and there can be no doubt that by his own efforts and achievements he did much towards giving practical effect to the policy of conservation and research inaugurated by Lord Curzon in 1902 Up to that date, official efforts to preserve the monuments of past ages and to investigate the hidden remains of antiquity were "spasmodic, desultory, unscientific and planned on a penurious scale" With the appointment of a Director-General of Archæology and a staff of able assistants, among whom Dr. Spooner was deservedly considered one of the most capable, there began that enormous development of historical and archæological study which has been one of the most striking features of the twentieth century in India.

Dr. Spooner did excellent work as Superintendent of the difficult Frontier Circle; but his name is more likely to be remembered in connexion with his excavations at Pataliputra, now known as Patna, the ancient capital of the Maurya dynasty of Magadha, and with the somewhat startling theory which he advanced as to the origin of the family of Chandragupta and his successors The fact that the palace of the Mauryas, discovered near the modern village of Kumrahar, was almost certainly designed in imitation of the Persian palace at Persepolis, together with other traces of Iranian influence upon the practice of the Mauryan court, led Dr. Spooner to assert that Chandragupta and his successors were of Persian origin. This theory, which he published in the Journal of the Royal Asiatic Society, has been accepted by no one except, possibly, certain Parsi scholars, who were naturally gratified at the idea of a "Zoroastrian period" of Indian history. But while no one disputes the fact that Persian institu-

tions were familiar to the people of northern India in the fourth and third centuries B.C., the assumption of an Iranian origin for the rulers of Magadha has no historical warranty at present, and involves the rejection of important traditional and literary evidence as to their descent

Dr. Spooner's research work at Kumrahar needs no commendation, and he was probably led into his novel speculations about the Mauryas by his intense enthusiasm—the very quality which, combined with sedulous activity, rendered him so valuable a servant of the Government of India *Ave atque vale.* S. M. E

WE regret to announce the following deaths:

Sir Anderson Critchett, Bart., K.C.V.O., surgeon-oculist to the King, first president of the Council of British Ophthalmologists, president in 1894 and 1899 of the Ophthalmological Society of the United Kingdom and in 1913 of the Ophthalmic Section of the International Medical Congress held in London, on February 9, aged seventy-nine

Dr. Horace T. Brown, F.R.S., distinguished for his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures, on February 6, aged seventy-six.

Current Topics and Events.

WIDESPREAD interest has been aroused among the general public by the publication of Prof. Dart's account of the discovery of *Australopithecus africanus*, or the Taungs Man, as the Press has elected to call him, in last week's issue of NATURE. Although the discovery dated from November last, the news had been carefully guarded, and it was only when a cable was received in England on February 4, and appeared in the Press on the following day, on the eve of the publication of the article in NATURE, that it became known. Notwithstanding the absence of precise details, the importance of the news was at once recognised by the leading London and provincial daily papers, which quoted freely from Prof. Dart's article as soon as it was available. In another part of this issue, Sir Arthur Keith, Prof. G. Elliot Smith and Dr. W. L. H. Duckworth discuss the significance of the discovery.

THE debt which the modern civilised world owes to science has seldom been acknowledged so generously, or expressed so eloquently, by responsible statesmen as by President Coolidge and by Mr. C. E. Hughes, Secretary of State, in their addresses to the recent meeting of the American Association for the Advancement of Science at Washington, D.C., which have been printed in a recent issue of *Science*. No other single agency, says the President of the United States, has relied so much upon the work of men and women of science as has his government, which has been foremost in employing and most liberal in endowing science, although it cannot claim to have been "impressively liberal" to the scientific workers whom it has employed. The scientific work done under the administrative departments has, he says, been of enormous value to the whole people. Men of science are "the wonder-workers of all the ages", the discoveries made by them have become commonplaces because their number has paralysed the capacity of the mind for wonderment. Representatives of social and political organisations regard the march of science with awe, and sometimes with fear, when they ask themselves what will be the next revolution to which their schemes will have to be adapted; but the conviction that science works for the public weal, and that at the worst it saves life from being very monotonous, restores their confidence. It has taken endless ages to create in men the courage that will accept the truth simply because it is the truth. Comparatively few men are sufficiently gifted to be able to use the scientific method in seeking for the truth, but they no longer fear the results to which it leads. Truth is essential, and therefore all encouragement should be given to men of science and of faith.

MR. HUGHES spoke on the value of science in promoting international co-operation and concord. Science may forge new and terrible weapons of destruction, but she is far more eloquent as she points to the wastes of strife, to the retarding of progress, and to the vast opportunities which are open to those peoples who will abandon mutual fears and destroy artificial barriers to community of enterprise. Each nation should collect, collate, and safeguard all data and records made within its territory, and should make them readily available to other nations. International co-operation in research is absolutely necessary, and both national research organisations and the International Research Council are doing good work and opening up a new era of international co-operation in science. Scientific method is needed in government, in making and administering the law. The scientific attitude of mind is needed because it comprises search for pure knowledge, distrust of phrases and catchwords, hatred of shams, willingness to discard outworn beliefs, and, above all, faith in humanity and zeal for the public good.

THE Right Hon. T. R. Ferens, High Steward of Hull, has presented to Hull the princely sum of 250,000*l.* as a nucleus towards a University College for the city. In his letter to the Lord Mayor announcing his intention of making the gift, Mr. Ferens stated that he had carefully consulted university professors and others interested in educational matters, and was satisfied that the time was arriving when Hull should join other cities, such as Birmingham, Manchester, Liverpool, Leeds, etc., in giving opportunities to its sons and daughters for higher education. We believe it was at the meeting of the British Association at Hull, when the retiring president, Sir Edward Thorpe, and the president, Sir Charles Sherrington, were the guests of Mr. Ferens, that the idea was first suggested. In addition to this magnificent gift, a new Art Gallery, costing something like 90,000*l.*, together with its site in the centre of the city, has been presented by Mr. Ferens.

He has given more than 11,000*l.* towards pictures for the permanent collection, without which the probability is the present Art Gallery in the City Hall would not have existed Other gifts of Mr Ferens include more than 9000*l.* for the site for a new technical college, amounts set aside for scholarships, playing fields; almshouses, boating-lake, and similar objects.

LONGEVITY among scientific men is exemplified in a signal manner through the ninetieth anniversary of the birth of a distinguished zoologist, the Rev. T. R R Stebbing, F.R.S , an event which occurred on February 6, and was duly celebrated at his home at Tunbridge Wells The record of the Stebbing family with the Royal Society, from father to son, is noteworthy when we recall that 1765, 1845, and 1896 are, respectively, years of family elections into that body Born in London, Mr Stebbing was the fourth son of the Rev Dr. Stebbing, many years acting editor of the *Athenæum*, indeed almost from its foundation in 1828. Incidentally, we may remark that the third son, Mr William Stebbing, for long Delane's right-hand man on the staff of the *Times*, is also alive Mr Stebbing's life studies in zoological science have been concerned principally with the Crustacea His report upon the Amphipoda of the *Challenger* Expedition occupies three quarto volumes, comprising 1774 pages of letterpress and 212 plates It was accompanied by a bibliography giving a critical report of everything that had been written respecting these Crustacea from the time of Aristotle to the year 1887 This detailed analysis occupies more than 600 pages, being in fact a complete history of the group Mr Stebbing has always been greatly interested in promoting local scientific societies His efforts in this connexion in the south-east of England, jointly with the late Mr. George Abbott, were referred to in NATURE of February 7, p 201 Mr Stebbing was zoological secretary of the Linnean Society, 1903–1907, and Linnean medallist, 1908. We proffer our heartiest congratulations to him upon the auspicious occasion of a nonagenarian birthday

DR. J H JEANS gave the sixteenth Kelvin Lecture to the Institution of Electrical Engineers on February 6 He chose as his subject electrical forces and quanta, and gave a masterly résumé of the theories of relativity and quanta. Starting with Einstein's hypothesis he stated that the whole theory of gravitation and of electromagnetic forces can be worked out by pure geometry When, however, we come to the theory of quanta we have to determine the magnitude of the quantum, and so it is necessary to have recourse to experiment He considers that there is now no room for doubt as to the substantial accuracy of Einstein's relativity theory It provides a general dominating principle, to which all phenomena must conform It helps us to discover the laws according to which events occur, but has nothing to do with why they occur. It is unscientific to suppose an ether unless there is an absolute necessity for it The hypothesis is unnecessary, in Dr Jeans's opinion, as the explanations are entirely satisfactory without it. *A fortiori* it is hopelessly unscientific to presuppose two or more ethers. In his opinion the last twenty-five years will rank as one of the most fruitful and important periods in the history of physics. In an hour the lecturer covered a very wide field. He touched on Rutherford's, Bohr's, and Sommerfeld's theory of the atom. He pointed out that the explanation of line spectra is one of the most satisfactory in the whole range of physics, the numerical accuracy of the theory rivalling the most accurate of astronomical calculations. He is of opinion that the theory of a mechanical ether believed in by Faraday and Maxwell is dead. As soon as we pass beyond the minute range covered by the Newtonian mechanics and the classical electro-dynamics, the picture presented to us by the quantum dynamics takes us by surprise We find that Nature consists of a series of abrupt jumps These jumps are so minute and so close together that they produce the illusion of continuous motion, and no satisfactory mechanical explanation has yet been given

THE fourth annual report of the British Electrical and Allied Industries Research Association has now been published It is stated that the results obtained last year represent a real contribution to progress in the affected industries, but nothing of a spectacular character has been discovered Hitherto commercial research has been concerned mainly with the finding of the values of physical constants Little has been done in the way of obtaining new scientific knowledge It is stated that the discoveries of Sir J J. Thomson and Sir E Rutherford are opening up immense fields of knowledge which may not only revolutionise existing methods of design but even alter the nature of the activities of the whole industry. The Association is giving close attention to the possibilities of work in this direction It is considered, for example, that there is necessity for fundamental research on a large scale into the phenomena of dielectrics This of course is of great interest to the cable and therefore to the whole electrical industry We shall be very interested to note the results of these great schemes of co-operative research

THE late Mr. Thomas L. Gray, who died about a year ago, bequeathed the residue of his estate, which is expected to amount to about 7000*l.*, to the Royal Society of Arts for the purpose of founding a memorial to his father, Thomas Gray, formerly head of the Marine Department of the Board of Trade. According to the Society's journal, the bequest is to be known as "The Thomas Gray Memorial Trust," and the income derived from it is to be devoted to "the advancement of the science of navigation and the scientific and educational interests of the British Mercantile Marine." It is suggested in the will that these objects may be achieved by offering prizes for new inventions relating to navigation, by making grants for scientific research and for lectures on the subject, and by providing scholarships for students or teachers and offering prizes for essays on and awards for the saving of life at sea. Thomas Gray

was in charge of the Marine Department during the 'seventies and 'eighties, when British shipping was developing rapidly, and took a prominent part in formulating the present system of regulation and control.

THE issue of *Die Naturwissenschaften* for January 16 is devoted to an account of the foundation on January 14, 1845, of the Physikalischen Gesellschaft of Berlin by Profs. Beetz, Brücke, Karsten, Knoblauch and Du Bois-Reymond, and its subsequent history Profs Warburg, Goldstein, Scheel, Pringsheim and Planck are responsible for an interesting and well-illustrated account of the Society and its activities The five founders are shown in the frontispiece, which in itself makes an interesting study of professorial attire Profs Clausius, Quincke, Kundt and Kohlrausch form another group, and separate portraits are given of Profs Riecke, Warburg, Brucke, Kirchhoff, Helmholtz, Halske, Weierstrass, G. Wiedemann, Kronecker, Schwalbe, Werner Siemens, Hagenbach, von Bezold, Foerster, Planck and Goldstein. As the Society developed out of the physical colloquium founded by Prof. Magnus in Berlin in 1843, it is fitting that Prof. Pringsheim's recent address to the Society on the Magnus effect, its theory as developed by Prof Prandtl and its application by Dr Flettner, should be given a prominent place and that the original figures of the Magnus paper should be reproduced.

THE final sale of the Crisp collection of microscopes takes place on Tuesday, February 17, at Stevens's Auction Rooms, where in 1920 and 1921 the other portions of the collection were sold In the catalogue which Messrs Stevens have issued, 371 lots are detailed, arranged in groups —(1) Simple microscopes and small pocket compound microscopes, (2) compound microscopes dating from the seventeenth century to the introduction of achromatism in the early part of the nineteenth century; (3) optical cabinets, solar and projection microscopes The various Nuremberg wooden microscopes form another small group. In each group, the instruments are catalogued approximately in chronological order. Illustrations are given of fourteen of the earlier and more interesting instruments, including the unique silver microscope made by G. Adams, a Hooke microscope, and original examples by Campani, Marshall, and Lindsay. The whole collection, which consisted of about 3000 microscopes, was formed during the latter half of the last century by the late Sir Frank Crisp, Bart., who became the leading authority on the history and development of the instrument. He frequently expressed his intention of presenting his collection to the Science Museum at South Kensington, so that it might become the property of the nation.

AT a meeting of the Dominions and Colonies Section of the Royal Society of Arts on January 27, Mr. W. R. Dunlop, lately professor of economics under the auspices of the Colonial Office, read a paper entitled "Economic Research in Tropical Development." Starting from the premise that the great question of economics is why some people, individually or collectively, are better off than others, Mr. Dunlop said that useful and illuminating results can be obtained in the tropical world, by contrasting one country which is undeveloped and poorly off with another that is relatively highly developed and extremely well off Taking British Guiana in South America, and British Malaya in the East, the total population and external trade of the former in 1923 were 300,000 and 6,426,607*l*, while those of the latter were 3½ millions and 147,945,860*l*. As countries go, both are similar in size (comparable to the area of the United Kingdom), both are fertile, and both have mineral and other resources The difference in extent of development is fundamentally due to (*a*) difference in world geographical position, (*b*) difference in mineral resources, (*c*) internal geographical disadvantages in the case of British Guiana On the whole, British Malaya is also more efficient industrially than British Guiana Concerning efficiency in public administration, Mr Dunlop directed attention to the fundamental importance of transport, public health, land administration, forestry and scientific research of all kinds in tropical economic development Comparison of existing policies in these matters in British Guiana and British Malaya shows striking differences In conclusion, Mr Dunlop said that he used British Guiana and British Malaya as illustrations providing data and proof for demonstrating the nature of the research he was advocating.

APPLICATIONS are invited for some junior professional assistantships at the Meteorological Office Candidates must hold an honours degree in mathematics or physics Written applications should be addressed to the Secretary (S 2), Air Ministry, Adastral House, W.C.2

THE Royal Aircraft Establishment, South Farnborough, Hants, is requiring a test assistant for aerial photographic work. Candidates should possess some knowledge of chemistry, preferably photographic chemistry, and be medically fit for flying Applications should be marked A. 46 and be sent to the Superintendent of the Establishment

SIR OTTO BEIT, Bt., F.R.S., Sir Sidney Frederic Harmer, F.R.S., Director of the Natural History Departments, British Museum, and Sir Frank Short, Royal Academician, president of the Royal Society of Painter-Etchers, have been elected members of the Athenæum under the provisions of Rule 11. of the Club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service

SHORTLY before 10 P.M. on February 1, a slight earthquake was felt in the south-west of Cornwall, at Penzance, Camborne, Truro, etc., and the Scilly Isles. Records have also come from Brest and Jersey. The disturbed area probably contained about 17,000 square miles, and its centre apparently lay to the west of the Channel Islands. In the much stronger earthquakes of January 28, 1878, and May

30, 1889, the centre lay to the east of Jersey It has been suggested that the shock was due to the subsidence of disused mine-works, but the greatest known area disturbed by such earth-shakes is less than 150 square miles, and, owing to the small depth of the origin in such cases, the intensity is always great near the centre of the area and declines rapidly outwards

At the annual meeting of the Royal Microscopical Society held on January 21, the following were elected as officers and members of the Council for the ensuing year *President*, Mr. A. Chaston Chapman; *Vice-Presidents*, Prof F J. Cheshire, Mr M T Denne, Sir Robert A Hadfield, Bart, Dr R J Ludford, *Treasurer*, Mr C F Hill, *Honorary Secretaries*, Mr J E Barnard, Dr J A. Murray, *Members of Council*, Mr S C Akehurst, Mr E W Bowell, Rev Canon G R Bullock-Webster, Dr H. G Cannon, Dr C Da Fano, Mr E H Ellis, Prof R Ruggles Gates, Mr T H Hiscott, Mr J W Ogilvy, Mr D J Scourfield, Dr C Tierney, Mr H Wrighton, *Librarian*, Mr R. Paulson, , *Editor*, Dr J W H Eyre, *Curator of Instruments*, Mr W. E Watson Baker, *Curator of Slides*, Mr E. J Sheppard

At the last meeting of the Illuminating Engineering Society on Jan 27, a paper was read by Mr J W T Walsh, of the National Physical Laboratory, Teddington, dealing with some little-understood aspects of the effect of shadows in lighting problems It is well known that the shadows cast by indirect lighting systems—for example, when light is received by reflection from a white ceiling—are so soft as to be inappreciable to the eye In fact such systems have sometimes been described as "shadowless" Mr Walsh was able to show that what the eye cannot perceive the photometer can detect, and that in fact the obstruction of light by a person's body or adjacent machinery, etc, may in such cases cause a very marked diminution in the available illumination Similar conditions apply when one is dealing with daylight from a white sky, yielding ill-defined shadows Methods of calculating the ensuing loss of light were suggested An interesting example of such effects was afforded by a room with white walls and ceiling which, when empty, appeared to be brilliantly illuminated, but when the room was occupied by bulky, dark-coloured machinery the illumination was found to be inadequate At the conclusion of the meeting it was mentioned that a special course of lectures, each given by an expert on some special aspect of illumination, is being arranged to take place at the Polytechnic, Regent Street, starting in April next.

With its January issue *The Marine Observer* has entered upon its second year. The former Director of the Meteorological Office, Sir Napier Shaw, contributes an interesting communication, "A Meteorologist at Sea," a reflection on meteorology when traversing the Atlantic for the recent British Association meeting in Canada The reflection roughly compares official meteorology as undertaken by Admiral Fitz-Roy in 1855-1865 with official meteorology as controlled by Sir Napier from 1900 until 1924. At the commencement of Sir Napier's official career at the Meteorological Office, a quarter of a century ago, weather observations were obtainable only at the central weather offices of different countries, and the area embraced was very much limited Now the daily map obtained embraces practically the whole of the Northern Hemisphere. It is only a little more than 60 years ago that charting the weather on daily maps was introduced into Great Britain by Admiral Fitz-Roy Much information is given in the periodical bearing on ships' wireless weather news, by means of which every opportunity is afforded seamen of constructing their own weather charts when at sea.

In the January issue of *Science Progress* Mr F W. Shurlock, Principal of Derby Technical College, gives an account of the Rev A Bennet, F R.S, curate of Wirksworth, near Matlock, and inventor of the gold leaf electrometer Unfortunately, the "Dictionary of National Biography" gives no account of Bennet and ascribes the invention of the instrument to George John Singer. The "Encyclopædia Britannica" and Wiedemann's "Elektricität" both give the credit to Bennet, and cite his paper in the Transactions of the Royal Society for 1787, in which the instrument is described. It is dated "Wirksworth, Sept. 14, 1786," and as Singer was born in this year there can be no question of priority Mr. Shurlock quotes the description of the instrument, the method adopted for getting an electric charge from the air by means of a flame and the method of doubling the charge obtained Bennet's Royal Society papers form the basis of his book, "New Experiments on Electricity," published at Derby in 1789 He appears to have been a master at the Free Grammar School at Wirksworth, and there is a quaint portrait of him in the vestry of the parish church. He became rector of Fenny Bentley near Ashbourne in 1796 and died there in 1799.

The "Arcadia" projector, shown in operation at the King's Cross Cinema on February 4, has several novel and distinct features Hitherto the projection of "living pictures" has been based on the use of an automatic shutter alternately opening and closing, and presenting a rapid succession of "still" effects. The shutter causes a rapid alternation of light and darkness and is liable to cause more or less flicker. The new projector makes use of a complex arrangement of rotating mirrors, whereby successive pictures are imposed, but throughout the process there is substantially the same amount of light on the screen, and it is claimed that this removes one potential cause of eye-strain. In addition the method gives rise to a certain degree of stereoscopic effect The mechanism of the projector and the method of feeding the film also present novel features, conducive to greater steadiness and more silent running, and the amount of wear and tear of the film is stated to be very much reduced. A similar projector was demonstrated at the Imperial College, South Kensington, on February 10, 1921, and described in our issue of February 24, 1921, p. 841.

THE recently amalgamated firms of T. Cooke and Sons, Ltd., and Troughton and Simms, Ltd, 3 Broadway, Westminster, S.W 1, which went into voluntary liquidation several months ago, inform us that this state of affairs has now been satisfactorily terminated They wish it to be known that their facilities for designing and manufacturing high-grade scientific instruments and apparatus in large quantities have been retained intact, so that they are able to deal with orders as hitherto

MESSRS Adam Hilger, Ltd, have recently issued a handsome catalogue of their various manufactures It includes thirteen sections and is provided with a thumb index for ready reference as well as a general index at the end. The instruments described and illustrated in the sections come under the following headings:—Echelon diffraction gratings and Lummer-Gehrcke parallel plates (including echelon gratings having as many as 56 plates), spectrometers and goniometers, wave-length spectrometers, monochromators and specialised spectroscopes, spectrographs, accessories for spectrometers and spectrographs (including, among other things, heliostats, vacuum tubes, thermopiles and high purity electrodes of copper, iron, carbon and nickel), spectrophotometers, colorimeters, and apparatus for sensitometry (including the new Judd Lewis sector photometer), diffraction gratings; micrometers, etc, polarimeters and refractometers, Michelson, Fabry and Perot, and Hilger interferometers, spectroscopic apparatus for high resolving power, optical work, and the Low-Hilger audiometer. The instruments are well described and appear to be constructed with the care and with the view of convenience in use for which this firm is well known It is unfortunate that they cannot be produced at a lower price, however, as many to whom they would be of great value will find some of the charges prohibitive.

MESSRS. Gallenkamp and Co., Ltd, of 19 Sun Street, Finsbury Square, London, are to be congratulated on the new issue of their catalogue of apparatus for the examination of soil Until now, the recent striking advances in the technique of agricultural science, especially in physics and physical chemistry, have not induced the scientific apparatus firms and instrument makers to introduce the new apparatus to general notice This has been a real disadvantage to the research worker in soils It has usually been possible to persuade a firm to make a copy of some particular apparatus, the construction of which was beyond the ordinary laboratory facilities, but this is a very expensive way, as all the special costs are chargeable to the one apparatus. On the other hand, when an apparatus is listed in a catalogue, not only does it bear a smaller share of the overhead charges, but the publicity usually results in increased sales, which act in the same direction Messrs Gallenkamp's catalogue is divided into five sections soil sampling tools, physical properties of soil, soil solution, chemical analysis of soil, and soil meteorology Each of these sections contains items that well show the recent advances in the technique of agricultural science The newer forms of soil sampling tools are to be commended, and in the sections on physical properties of soil and soil solution, prominence is given to apparatus devised at the Rothamsted Experimental Station The section on soil meteorology has been carefully thought out and should be of considerable use in the development of work that, coming on the border line between meteorology and soil physics, has been rather neglected

MESSRS. Longmans and Co have in preparation a new and cheaper edition of Thorburn's "British Birds" The work will be in four volumes, illustrated by 192 coloured plates reproduced from new drawings by the author It is hoped to issue the first volume in March, the second in the autumn, and the remaining two volumes in 1926

SOME 1900 books on geology, palæontology, and mineralogy from the libraries of the late Sir Jethro J. H. Teall, and Messrs T W Reader and E A. Walford, are offered for sale in Catalogue No 123 by Messrs Dulau and Co, Ltd, 34 Margaret Street, W 1, together with a number of other works on fossil plants, anthropology, archæology, and zoology Copies of the catalogue can be obtained on application

Our Astronomical Column.

PHOTOGRAPHY OF THE ASTRONOMISCHE GESELLSCHAFT ZONES.—Prof Schlesinger gave an interesting account at the meeting of the Royal Astronomical Society on Jan. 10 of the reobservation by photography, at Allegheny Observatory, of some of these zones The novelty of the method lies in the size of the plates used, some of which are 5° in the side, others 12½°. The lens is a triple one, and the only form of distortion present is a tendency for bright stars to appear slightly displaced away from the centre as compared with faint ones; the amount near the edge is 0·06″ per magnitude. As each star is present on at least two plates, with the shift generally in opposite directions, no systematic magnitude error is introduced.

Although the scale is only half that of the Astrographic plates, the excellence of the lens is such that the probable error of each star image is only 0·18″.

Incidentally, the measures give the means of determining magnitude error in the Astr. Gesell. Catalogues For on plotting the differences of R A, Allegheny *minus* A G, for different magnitudes, the abscissa being Right Ascension, sine curves are obtained due to the solar motion The zero line of these curves is found to alter with the magnitude, now as magnitude equation on the photographs is shown to be eliminated in the mean, the effect must be due to the equation in the A G. Catalogues

Prof. Schlesinger is on his way to South Africa to inaugurate the photographic work with the instrument which is being sent there from Yale Observatory. He hopes to return in time for the meeting of the Astronomical Union at Cambridge in July. It may be mentioned that the 12½° × 12½° plates are a quarter of an inch thick and weigh 10 lb It would only need some 270 of these plates to cover the entire celestial sphere, so that the taking of the plates is a much less serious matter than that involved in the Astrographic Catalogue. The chief labour lies in the measurement and reduction.

Research Items.

THE PRESERVATIVE PROPERTIES OF HOPS.—For many years it has been assumed that the preservative properties of hops are directly proportional to the percentage soft resin content. In view, however, of the objections inherent in Brown's method of evaluating the former, it is welcome to find in a recent paper by Mr A Chaston Chapman (Jour Inst. Brew., 1925, xxxi 13) the description of an improved biological method To varying amounts of a 1 per cent. aqueous infusion of the hops, in a medium of nutrient agar, were added a few drops of a culture of an organism isolated from raw sugar, and specially sensitive to the inhibitory effects of hop extract. After incubation for 18 hours at 37° C on petri dishes, the mixtures were arranged in order of bacterial development, the end-point being represented by a dish containing few or no colonies, followed by one containing a large number The end-points were sharp and concordant, and within reasonable limits, were independent of the strength of the infusion and of the number of successive digestions of the same sample The author suggests that the preservative material, though highly insoluble, is being produced continuously during the extraction Whereas no quantitative connexion between the soft resin content and the preservative value is apparent, experiments on the cold and ordinary storage of hops show that both these properties diminish at a slower rate in the former case Apparently the two properties are associated in some way not yet clear, the quality rather than the quantity of preservative material being the important factor. Methods of estimating resin content by direct extraction are criticised, and an improvement giving higher results is suggested for soft resins. These are now extracted in a Soxhlet apparatus by petroleum ether from the total resin solution spread on an Adams milk-analysis paper.

DETERIORATION OF STRUCTURES IN THE SEA.—The fourth (interim) report of the Committee of the Institution of Civil Engineers on the Deterioration of Structures in Sea-water was published in December 1924, although the report itself is dated September 1923 and deals, for the most part, with investigations carried out in 1922 It includes a paper by Mr. E J M'Kaig and Dr. J Newton Friend describing a steel landing-stage at Weston-super-Mare which, after standing for fourteen years, developed structural defects and had to be taken down. One point of interest was the unexpectedly large amount of corrosion at the point where the piles entered the sea-bottom, due, apparently, to the slow drift of sand against the piles Other evidence also suggests that a very slight amount of mechanical wear greatly accelerated the chemical action of the sea-water on the steel Investigations relating to the preservation of timber from marine boring animals are reported on by Prof G Barger and Mr. C. M Yonge. As the work of the latter only extended over a period of six weeks, it was scarcely to be expected that much would be added to our knowledge of the life-history of Teredo The results of experiments in poisoning the larvæ with the arsenic compound "D M." are in striking contrast to the American observations recently reviewed in NATURE (November 22, 1924, p. 745). The species studied at Plymouth by Mr. Yonge was identified as *Teredo norvegica*; Prof. Barger does not give the name of the species which he observed at Lowestoft, but as he refers to "Teredo" as a "species," it is plain that he does not consider the point of much importance. An account is given by Mr. J. M'Glashan and the late Dr. N. Annandale, of damage done to brickwork in the Calcutta docks by the boring mollusc *Martesia fluminalis*. It should have been mentioned that Dr. Annandale's report printed here was published more than a year ago in the Journal of the Asiatic Society of Bengal (vol. xviii. No 10, p 555).

EXTINCT RHINOCEROSES OF CHINA.—The Geological Survey of China has published an important work by Dr. Ringström of Upsala on the Rhinoceros and Hipparion Fauna of North China (Provinces of Shansi, Shensi, and Honan). The present volume is part iv., series C of volume i., 1924, and deals entirely with the rhinoceroses In it a new genus of the short-legged teleocerine rhinoceroses is described under the name Chilotherium. A new genus of great interest, Sinotherium, of which Ringström had already published a preliminary account, is also here more fully described The genus is closely allied to Elasmotherium, that curious rhinoceros with extraordinary complicated teeth and large hump over the eyes and nose, of which the British Museum has recently acquired a fine skull The paper is fully illustrated with many text-figures and twelve plates, and its value is further enhanced in that the author gives his views on the position of certain Asiatic and European rhinoceroses.

AN AMERICAN EXTINCT FAUNA.—A bulletin of the American Museum of Natural History (vol 50, article 2) contains a third part of Dr. W D Matthew's studies on the Snake Creek fauna In it will be found a short notice of the stratigraphy of these important Miocene and Pliocene quarries whence the specimens came, together with remarks on the distinctions between the faunal zones and correlation of the faunas. The list of the vertebrate fauna, numbering more than a hundred species of mammals and including the celebrated tooth of *Hesperopithecus haroldcookii*, together with a sprinkling of birds, reptiles, and amphibia, is an impressive one. The bulk of the paper is devoted to an account of the various forms and, as is usual with this author, is no mere dry description, but is illuminated throughout by his discussion and views as to the evolution and relationship of the various forms, such as the phylogeny of the Canidæ and questions concerning the horses.

THE METEOR CRATER OF ARIZONA.—The Indians of Northern Arizona have a legend that a god visited them from heaven in a great chariot of fire which illuminated the sky and finally disappeared into the ground. It seems probable that the chariot was the gigantic meteorite which has been held responsible for the origin of the remarkable crater of Canyon Diablo. That the impact theory is correct seems to be established by the work of D. M. Barringer (Proc. Acad. Nat. Sci. Philadelphia, 1924, p. 275) He predicted in 1909 that the main bulk of the meteorite would be found under the southern wall of the crater. An exploratory boring has now been sunk near the southern rim, and at a depth of 1346 ft., highly oxidised meteoric iron was met with After passing through 30 ft. of this material the tools jammed, and no further progress was possible. Barringer considers the main meteorite approached the earth from the north at an angle of roughly 45°, leaving a scattered trail of the well-known Canyon Diablo meteorites. These have been found to contain platinum, and according to the *Winslow Mail*, of Arizona, a company has now been formed

to mine the deeply buried mass, which has been estimated to weigh a thousand million tons, by running drifts into it from the low country to the south of the crater rim The unique history of Meteor Crater should therefore be gradually disclosed during the next few years more completely than could ever have been anticipated before the possibility of platinum suggested mining exploitation.

PETROLEUM: ITS GENESIS AND GEOLOGY.—An article from the pen of Prof James Park and bearing this title appeared in the September number of the New Zealand Journal of Science and Technology (1924), it presents a very fair résumé of the subject, though it was obviously written for the purpose of general knowledge rather than to pave the way for possible oil explorations within the Dominion From the tectonic point of view New Zealand, as is the case with Australia, does not offer inducement as a country of potential petroleum reserves, though evidence of oil is by no means lacking, this does not, however, imply accumulation on a commercial scale. The author makes the interesting statement that "The seepages of oil found at Taranaki, and at Waiotapu in the King-country, New Zealand, occur in Tertiary rocks; and there is good reason for the belief that the oil has originated from the destructive distillation of the underlying seams of lignitic coal" This theory, even if well founded, tends to make it all the more improbable that there is any economic future for oilfield development in this country This is the only specific reference to petroleum in New Zealand In the paragraphs discussing the general geology of petroleum, the author refers to the porosity of oil-sands and states that "a porosity of 10 per cent is equal to 750 barrels of oil per acre-foot. The recoverable oil ranges from 50 to 75 per cent of the oil in the sands" This last sentence is open to some doubt, especially with present-day methods of oil production, in practice a 30 per cent recovery is considered good, Uren places the maximum at about 40 per cent, and with a 25 per cent porosity and complete saturation this could probably be achieved Writing of oil migration, the author attributes this to "the differences of the specific gravities of oil and water" as being "the most powerful cause"; the researches of Munn and others have demonstrated clearly that movement and pressure of underground water are far more potent causes, as, indeed, may be gas pressure and capillary attraction. The article is, on the whole, a curious mixture of orthodox statement and original comment; it is in many respects to be regretted that the author does not also give us a fuller description of the known occurrences of bitumen in his country, notwithstanding that they may have little commercial value.

SOME USES OF PEAT.—One commonly regards peat in domestic use as a form of clean, cheap, though not always very efficient fuel, and such it probably is in most countries. It may come as a surprise to some people, therefore, to learn that in that land of varied and abundant fuels, the United States, by far the greatest quantity of peat produced is utilised in the form of fertilisers or as an ingredient of fertilisers, no less than 57,907 tons being marketed for this purpose in 1923, at a gross value of 351,641 dollars. The bulk of the United States peat comes from Illinois, New Jersey and California contributing the second and third largest outputs respectively. The use of peat as a stock-food is the next important activity in the industry, more than 3000 tons being produced for this purpose in the same year. As a fuel, the production (hence consumption) was practically negligible; in fact no return was made at all for 1923, and only 1040 tons were thus absorbed in the previous year Other uses (according to Mr. K. W. Cottrell in Mineral Resources of the United States for 1923, part 2) include its employment as peat moss, stable litter and packing material, much of which is included under the annual return for stock-food A somewhat curious fact is that peat moss imported for consumption in the United States has shown a steady increase during five years from 1919, when 464 tons were introduced, to 1923, when nearly 600 tons at a value of 43,184 dollars were imported, presumably from northern Europe, where the Sphagnaceæ are important constituents of peat Peat rich in these mosses has in other countries been successfully used in the manufacture of blankets, rugs, cardboard and cork-like materials, and it may be that some such use is being found for it in the United States, though the present report makes no mention of the purpose for which peat moss is being imported

RESOURCES OF ARCTIC RUSSIA.—Under the Scientific-Technical Department of the Supreme Council of National Economy, Transactions of the Northern Scientific and Economic Expedition, Petrograd and Moscow, 1920–1924 (*in Russian*), are published the results of several expeditions for the exploration of natural resources of Arctic Russia The publication appears in separate parts, each one dealing with a special problem Most of the work has been directed towards the exploration of the mineral wealth of the country, and many important discoveries are recorded. Thus the report by I. I. Ginsburg (No 7 of the Transactions, pp 64) contains an exhaustive survey of the mineral resources of the coasts of the Kandalaksha Gulf of the White Sea, where gold has been found and extensive beds of mica have been studied, local silver and lead ores are also described, and sketch maps of mineral resources are given No. 18 of the Transactions (pp 75, 1924), by Beliankin and Kupletsky, and No. 20 (pp. 43, 1924), by Beliankin, Vlodavez, and Shimpf, contain further information on the mineral resources of the same territory collected during the expeditions of 1917 and 1922 respectively, these two papers include also considerable data on petrography and geology of the country No 16 of the Transactions, by A Fersman (86 pp, 1 map, 1923), includes a series of abridged reports of different authors on the results of expeditions to the Khibin ridge of the Kola peninsula, where a very extensive geographical, geological, and geochemical survey was organised during the years 1920, 1921, and 1922, full reports of the expeditions will be published in two volumes when all the materials collected are worked out Paper No 19 (pp 102, summary in English), by Prof K N Derjugin, presents results of exhaustive hydrological and biological exploration of the Barents Sea during the years 1921–1923 The author gives new evidence to prove that, besides the annual oscillations of temperature of water, there exist periodic variations in the Atlantic currents which appear to be subject to a cycle of 8-9 years Other hydrological elements, distribution of salinity and of oxygen, degree of transparency of water and character of ground, are also discussed. Lists of fauna are given (including descriptions of several new forms), and the conclusion is reached that the fauna of the Barents Sea is not arctic, but only sub-arctic, in its composition. The authors believe that periodical variations in the thermical state of the Barents Sea have a strong influence on the climate of Northern Europe.

WEATHER IN RHODESIA.—The Proceedings of the Rhodesia Scientific Association, vol. xxii., contains a discussion on "The Problem of Seasonal Forecasting," by Mr. C. L. Robertson. The method of

cycles is dealt with, but the longest local record available is only continuous for 35 years, which is quite insufficient Severe droughts are said to occur within a year or two of sunspot minima and heavy rains within a year or two of sunspot maxima A 19-year cycle, based on pressure variations, is suggested as influencing Rhodesian weather. Maps are given showing the variations of pressure over the globe for the months of February, May, August, and November Reference is made to the pressure values in the southern hemisphere to show the relation to Rhodesian weather Areas of high pressure, important centres of action for South African weather, are shown in the South Indian, South Atlantic, and South Pacific Oceans There is a movement of these centres to the north and south, and also to east and west The tracks are said to deviate from an average mean track, and the 19 years' periodicity is attributed to this movement Much detail is given with reference to the various cycles, and the inquirer will find much of interest. A connexion is referred to between the south-west monsoon rainfall in India and the rainfall along the east coast of Africa down to Rhodesia Based on the assumptions obtained, seasonal forecasts are being made and probably in time some success will be gained

HYDRODYNAMICS AND ELECTRICAL ANALOGIES —In the December issue of the *Journal de Physique*, Prof V Bjerknes shows how the general equations of hydrodynamics may be transformed so as to exhibit the close analogy between the movements and forces in the fluid and the currents and forces in electrodynamics By means of rotating cylinders, and arrangements for producing bodies the volumes of which pulsate about a mean value, or oscillate about mean positions, he has shown that the analogy is true experimentally He points out that both his theoretical and his experimental work are but generalisations and improvements of results published by his father forty-five years ago Amongst the analogous systems referred to by the author may be mentioned the lines of flow about a pulsating sphere and the lines of force about a magnetic pole, the lines of flow due to an oscillating sphere and the lines of force of a short magnet, the lines of flow due to two parallel cylinders rotating in opposite directions and the lines of force due to two parallel electric currents flowing in opposite directions, a cylinder rotating in a stream of fluid (the Magnus effect) and a wire carrying electric current in a magnetic field.

HEATS OF OXIDATION —The heats of oxidation of certain metals in a pure state have been redetermined by J. E Moose and S W Parr (J Amer Chem Soc, Dec 1924). A very accurate bomb method was used. The values, in calories per gram of metal, for some of the more important metals are aluminium, 6970, beryllium, 14,879, zinc, 1298, magnesium, 5996, cerium, 1661

ISOLATION OF HYDROXYLAMINE —C de W. Hurd and H J Blounstein, in the Journal of the American Chemical Society for January, describe a new method of isolating free hydroxylamine from the hydrochloride The latter is decomposed with a butyl alcohol solution of sodium butylate, the sodium chloride is filtered off and the filtrate cooled to −10°, when half the hydroxylamine crystallises out. Methods of utilising the half remaining in solution are described.

ATOMIC WEIGHTS OF SILVER AND CARBON —The atomic weights of silver and carbon have recently been determined by Dr. G. Dean by the reduction of pure silver cyanide and cyanate in a current of hydrogen (J Chem. Soc., Dec. 1924). Assuming O = 16, Ag = 107 88, and N = 14·008, then the ratio AgCN . Ag gave C = 12·002 ± 0·001. Similarly, the ratio AgCNO : Ag gave C = 12·003 ± 0·001. By combining these ratios, and assuming only that O = 16, then Ag = 107·871, and the radical CN = 26·008, which, on subtraction of 14·008, gives C = 12·000.

ELECTROLYSIS OF SOME ORGANIC SALTS —The electrolysis of salts of some alkyloxyacids is described by D A Fairweather in the Proceedings of the Royal Society of Edinburgh (1924, vol. 45, Part I., No 4). The potassium salts of ethyl ethoxymalonic, ethyl diethoxysuccinic, and ethoxyacetic acids, and sodium amyloxyacetate were used. The chief products are of an aldehydic nature. Hofer and Moest's explanation of the formation of formaldehyde from the electrolysis of sodium glycollate is shown to be applicable to the cases studied, in one case (potassium ethyl ethoxymalonate) the intermediate compound postulated by these investigators was identified in the electrolysis products, owing to its being quite stable.

CARBONISATION TESTS —The Fuel Research Board has issued a Technical Paper No 10 on the carbonisation of a South Wales gas coal (Meiros Colliery, Llanharan) in Glover-West continuous vertical retorts. The report gives the results of carbonisation tests resembling in scope and procedure those made on several gas coals from other coalfields (See F.R B. Report, 1920–21, and Technical Paper No 8) In particular, the effect of steaming was observed and the variation in the results obtained when the percentage of steam was increased from nil to 20 per cent of the coal treated The results are fully tabulated and summarised in conjunction with those obtained from other gas coals, which they follow in general lines The tests form a part of the scheme of the Board to prosecute a survey of the national coal resources, and the compilation and ascertainment of such results will undoubtedly have a value which will be greater as the data available become more complete

EXPANSION OF ALLOYS.—The eighty-fifth report from the Research Institute for Iron, Steel, and other Metals, Sendai, by Kotaro Honda and Yosikadu Okubo, deals with the measurement of the coefficients of thermal expansion for certain alloys. The apparatus used was the same as that constructed some years ago by Honda. It is a modified form of Chevenard's dilatometer The entire apparatus can, if necessary, be enclosed in a bell jar which can be evacuated so that the oxidation of metal specimens is avoided. Data are given for certain aluminium alloys, particularly those used in aviation The results obtained with alloys of iron and nickel are interesting On adding nickel to iron, the coefficient of expansion decreases slightly up to 18 per cent. of nickel and then increases to 25 per cent. From 25 per cent it decreases rapidly to 36 per cent. and afterwards increases, rapidly at first, and above 50 per cent. gradually, up to pure nickel These results coincide with those of Guillaume, the alloy of minimum coefficient of expansion being approximately of the same composition as that of invar So far as iron-cobalt alloys are concerned, the variations are much smaller. On adding cobalt to iron the coefficient of expansion decreases gradually to a minimum of 48 per cent., and rises gradually to the concentration of pure cobalt.

The Water Supply of Egypt and the Sudan.

IN the report recently issued[1] by the Physical Department of Egypt on the discharges and levels of the Nile and the rains of the Nile Basin for 1919, we have a revival of the reports on the rains of the Nile Basin which, after appearing for eight years, were discontinued on the outbreak of the War.

This report differs from its predecessors in an important respect; the volumes discharged by the Nile and its tributaries now take the first place, and the rainfall measurements form but a minor portion of the volume. This is an indication of the advance which has been made in late years by the Physical Department in the accurate gauging of the Nile supply, a matter of the highest importance both to Egypt and to the Sudan. While formerly most of the determinations were dependent on the accuracy of curves constructed to show the relation between a gauge reading and the corresponding volume of the discharge, we are now presented with no less than 465 measured discharges taken during the year 1919. Of these 210 were on the Blue Nile, 74 on the White Nile, and 138 on the main stream. This gives a precision to the results and an authority to the deductions which may be drawn from them that puts the hydrographic work on the Nile on a very high level.

The discharges have been measured with Gurley's pattern of current meter, and these instruments are rated from time to time at Cairo. It has been suggested that discharges measured during the flood are too large in consequence of the meter being affected by the turbulency of the water, but recent experiments by Mr. B. H. Wade show that this effect has been much overestimated.

The characteristics of the Nile regimen are well brought out in the table; the low stage flow of only 50 cubic metres per second of the Blue Nile in April, and the rapid rise to 8000 cubic metres per second at the beginning of September, in a year when the Abyssinian rainfall was about 30 per cent. below the average, shows how vast a volume of water pours down to the Sudan and Egypt at this season of the year. There is at this time ample water for the needs of the Sudan in the neighbourhood of the Blue Nile when Egypt is receiving more than its land can possibly utilise.

The discharges of the White Nile show a wholly different type of supply, it varied from about 600 cubic metres per second in April and May to 1300 cubic metres per second in October and November, an increase due to water brought in by the Sobat river, which in 1919 received an unusually small supply from the southern plateau of Abyssinia.

There are now 48 river gauges on the Nile and its tributaries south of Wadi Halfa which are read regularly, besides 9 on Lakes Victoria, Kioga, and Albert in Uganda.

The rainfall throughout the Nile Basin is presented in a series of tables, and in most places it was below the normal in 1919. Consequently the level of the lakes on the Lake Plateau of Uganda fell generally, on the Bahrel Jebel the summer rainfall was good, but the extent of marsh in this region prevents the discharge in the lower reaches from gaining by it. The rainfall on the Abyssinian plateau was considerably below the normal, so that the volume passing Wadi Halfa was below the average throughout the year except in July, August, and September, and in November the defect reached 23 per cent.

When we remember that the Nile for the last two thousand miles of its course flows through arid or semi-arid regions, the importance of accurate hydrographical information such as this cannot be overestimated.

H. G. L.

[1] Ministry of Public Works, Egypt. Physical Department. "The Discharges and Levels of the Nile and Rains of the Nile Basin in 1919." By P. Phillips. Physical Department Paper No. 11. (Cairo: Government Publications Office, 1924.) P.T.5.

Occurrence and Use of Bitumen.

IN a recent report (No. 625) of the Mines Branch of the Canadian Department of Mines, Mr. Sydney C. Ells contributes a summary account of the nature, mode of occurrence, exploitation, and commercial development of the famous "tar sands" of Northern Alberta, Canada. The report forms an appendix to the author's former "Preliminary Report on the Bituminous Sands of Northern Alberta," No. 281, published in 1914, but for some years out of print. The present summary contains the results of further field-survey of the deposits, including examination and sampling of the sands, a résumé of modern methods of recovery of the bitumen from the sand, and some data concerning the laying of demonstration pavements and roadways.

The principal area of exposure of these sands is along the Athabasca River, outcrops occurring for a distance of more than 220 miles. The deposits are probably of Cretaceous age, though the origin of the bitumen is uncertain, a question which, however, is to form the subject of a report already in preparation. The impregnation varies with the texture of the sand, as would be expected, medium and moderately compact deposits being the richest, finely-graded material being the poorest in bitumen content. Attention is directed to the existence of impervious partings or strata within the deposits which act as horizons of concentration of the bitumen from overlying sands, presumably by downward migration. The more fluid seepages, known as "tar springs," are shown to have originated by lateral migration from slightly inclined beds of particularly rich, coarse-grained sand, the author states that such springs are not of commercial value as sources of bitumen, and further, that it is erroneous to regard them as indications of oil-pools, as has been done by certain geologists who have studied this region. The average bitumen content ranges from 20 per cent. to 25 per cent. in the richest deposits, to 15 per cent. in the normal impregnated sands; the crude bituminous sand has a gravity of 1·75 and a moisture factor of 1·3 per cent.

The commercial application of this material to paving and road construction must be considered as still being in the experimental stage, though results based on eight years of observation on a highway surfaced in three different ways, namely, with sheet asphalt, bitulithic and bituminous concrete, are certainly encouraging, since at the time of writing the author states that "the pavement [*i.e.* road surface] was still in first-class condition, and had required no repairs," notwithstanding that heavy traffic included, apart from motor cars, vehicles carrying loads up to ten tons. Crude bituminous sand is not recommended *per se* as paving material owing to its unbalanced mineral aggregate, lack of uniformity and to freight charges, though it is considered that an attempt should be made to produce an artificial mixture in which the inherent properties and qualities of the sand can be utilised to the greatest advantage. The report concludes with a valuable summary of processes employed for refining bituminous deposits of this character.

University and Educational Intelligence.

LEEDS.—Applications are invited for a lectureship in bacteriology, particulars of which may be obtained from the registrar. The latest date for the receipt of applications is February 23.

LONDON.—On Monday, February 23, Prof. W. T. Gordon will begin a course of twelve Swiney lectures on "The Geological History of Plants," at King's College, at 5.30 o'clock. The succeeding lectures will be given on February 25, March 2, 4, 9, 11, 16, 18, 23, 25, 30, and April 1. Admission will be free.

A free public lecture (in English) on "The Relation of Paralysis Agitans to the Parkinsonian Syndrome of Epidemic Encephalitis" will be given in the Lecture Hall of the Royal Society of Medicine, 1 Wimpole Street, W.1, by Prof. R. Cruchet, of the University of Bordeaux, at 5 o'clock on Wednesday, February 25.

A course of four public lectures on "Puerperal Sepsis" will be given by Prof. B. P. Watson, at St. Thomas's Hospital Medical School on March 2, 3, 4, and 5, at 5 o'clock.

PROF. WIELAND of Königsberg has been offered the chair of pharmacology at the University of Frankfurt.

DR. FRITZ HILDEBRANDT, lecturer at the University of Heidelberg, has been offered the chair of pharmacology at the Medical Academy in Dusseldorf.

DR. PERCY BRIGL, first assistant at the Institute of physiological chemistry in the University of Tübingen, has been nominated professor and director of the Institute of Agricultural Chemistry at the Agricultural Hochschule at Hohenheim.

DR. FRIEDRICH PASCHEN, who was recently appointed president of the Physikalisch-Technische Reichsanstalt, has been elected to an honorary professorship in the philosophical faculty of the University of Berlin.

NOTICE is given that the examinations for the award of the Tate Scholarships in engineering, science, and domestic science at Battersea Polytechnic for the session 1925–1926 will be held on June 9 and succeeding days. The annual value of the scholarships is from 20*l.* to 30*l.* each, with free tuition, and the tenure is three years. The last date of entry is April 18.

A LECTURER in botany at University College, Colombo, will shortly be appointed. Candidates for the post must hold a first-class honours British degree, with botany as the principal subject, or have equivalent qualifications, and should have had experience of lecturing or teaching. Particulars of the appointment and copies of the necessary forms of application are obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1. The completed forms must be returned by at latest March 1.

A JUDICIAL decision of interest to all who are concerned with educational finance was announced in the November number of *School Life*, the official journal of the Washington Bureau of Education. The Supreme Court of Oklahoma upheld the validity of a State appropriation to aid in paying teachers' salaries in districts that had levied the maximum school tax and still could not maintain their schools. The court held that the burden of education rests on the State, and that the local rates are in the nature of aid to the State, which is bound to take such measures as are necessary for financing the school system, so as to afford equality of opportunity throughout the State.

Early Science at Oxford.

February 15, 1683–4. Mr. Aston sent an account of ye ascent of water in a bolt-head, a great while *before* freezing; and that a peice of Ice, of 3½ inches thick, 4 broad, and a foot long, bore, in ye middle, ye weight of 350 lb, but with 400 lb, after some time, it broke, and (which is most surprising) that ye ice on ye Thames of late was not above 11 inches thick. The same letter told us, that Ice was asserted to be to water in weight, as 7 to 8: which differs not much from Mr. Desmasters late experiment.

Then my Lord Bishop of Ferns his Discourse, concerning Acousticks, and ye severall ways of improving the sense of hearing, was read.

Mr. Ballard acquainted ye company with his success in some late Experiments performed by order of ye company. A part of ye Rosemary stone (lately shewn us by Dr. Plot) after calcination in a charcoale fire, apply'd to a magnet as well as that which had been calcined in a seacoale fire. He chose to calcine it in a charcoale fire, haveing some suspicion it might receive some particles of iron, from ye seacoale, for he has formerly observed seacoal to be a kind of imperfect, or unripe iron-ore, because by an excessive heat of a forge it will flow, like molten metals, and then run to ye bottom of ye fire, where, haveing now lost all its combustible parts, it presently grows dead, and looking black, is cast out, a perfectly burnt cinder.

1686–7.—A letter from Dr. Garden of Aberdeen, Dec. 8, to Dr. Plot, gives an account of ye generation of ye small caterpillar, which infests blossoms of peares and apples, and destroys ye fruit *viz.* that they are not bred of mists and dews as Godartius thinks, but of eggs, from whence he draws several other inferences.

February 16, 1685–6.—Mr. Ash, secretary of the Philosophical Society of Dublin, described the case of a woman in ye North of Ireland, who fasted for ye space of eighteen weekes, and did not speak in almost all that time.—This gave Dr. Plot occasion to mention a silent woman now living at Wanborow in Wilts, who has not spoke in near twenty yeares, of whom he promises to procure a more full relation.

February 17, 1684–5.—A Nyctalops, or case of night-blindness, was described by Dr. Briggs. Being a schoolmaster, and able to answer such queries as shall be proposed to him, the Society agreed to send a list of queries, among which were: Whether this Person can see by Candle-light, in a darke room, any time of the Day? Whether, at any time, by candle-light darted through a Ball of water? Whether by ye light of Glow-wormes, rotten wood, Herrings heads &c.? Whether at any time, and by any light, with ye Bishop of Ferns his Spectacles? Whether his Eyes are equally affected?

A description of the Cicindela volans, by Mr. Waller, F.R.S. was read, and Dr. Plot affirm'd, that this Insect has been observed in Staffordshire.

Mr. Walker brought in an account of the prices of ye best wheat and mault at Oxford on the market-dayes next before Lady-day and Michaelmas for twenty yeares last past: by which it appeares, that the price of wheat for twenty yeares last past at a mean rate (*i.e.* one year with another) has been 5*s.* 4½*d.* ye bushell: mault, during the same time, in ye same market, at a mean rate, has sold at 2*s.* 11½*d.* ye bushell.

Mr. Cole promised patterns of Dyes of seven distinct colours from his Shell-fish, viz.: white, a fine yellowish green, a fair deep sea-green, a deep Watchet blew, a sullen purple, a deep dark sanguine, and ye bright Tyrian purple.

Societies and Academies.

LONDON

Royal Society, February 5.—H. M. **Carleton**: Growth, phagocytosis and other phenomena in tissue cultures of fœtal and adult lung. Invasion of the medium in a growing culture is the result of:—(1) Sheet-like epithelial outgrowth from the alveolar epithelium of cut alveoli. (2) Radiating growth of fibroblasts from the connective tissue of the lung. (3) "Membrane-formation," in which the cells of the cicatricial epithelium detach themselves from the implant. Within the implant there occurs a swelling up, and a detachment of, the alveolar epithelial cells. Mitoses are frequent in these—even in cultures of adult lung. Sterile coal or carmine particles are actively phagocytosed by both fœtal and adult lung *in vitro*. The alveolar epithelial cells are actively phagocytic, the dedifferentiated cells of the cicatricial epithelium less so.—F. W. **Fox** and J. A. **Gardner**: The origin and destiny of cholesterol in the animal organism. Part XIV.—The cholesterol metabolism in normal breast-fed infants. During the first week of life there is a daily average negative balance of 0·14 gram. This is to a large extent accounted for by the fact that the meconium is being got rid of. During the second and third week of life the average intake and output in the cases examined practically balance. At this stage the composition of the milk is in a transitional state from colostrum to true milk. In the last group of infants, from the seventh week to tenth month, there is an excess of intake over output, and the average positive balance is 0·069 gram per day. There must be some organ in the body capable of synthesising cholesterol, but the sterol present in the diet of infants is a source of supply which cannot be disregarded.—H. H. **Thomas**: The Caytoniales, a new group of angiospermous plants from the Jurassic rocks of Yorkshire. The fossils are the remains of megasporophylls with carpels, fruits, and seeds of two distinct types, and male inflorescences bearing stamens. They were found in the Gristhorpe Plant Bed in the Middle Estuarine Series, exposed on the Yorkshire coast in Cayton and Gristhorpe Bays. The species *Gristhorpia Nathorsti* gen. et sp. nov. had pinnate megasporophylls 4-5 cm. long, with an axis about 1 mm. wide, the sub-opposite pinnæ terminate in small more or less spherical carpels 2-5 mm. in diameter. The carpels have a stigma at the base near the pedicel. Winged pollen-grains were found on some of the stigmas. The seeds had a well-developed megaspore membrane with an apical projection, above which was a micropyle lined with cutinised cells. *Caytonia Sewardi* possessed megasporophylls agreeing generally with those of Gristhorpia, but the stigma was a small basal flange. The carpels and fruits contained two rows of ovules or seeds, with hard woody or stony testas. The remains of the male inflorescences are of a type previously known as *Antholithus* sp. and now named *Antholithus Arberi*. They were probably borne on the same plants as *Gristhorpia Nathorsti*. The anthers were four-lobed sessile structures, of a form very like that found in many modern Angiosperms, and had a longitudinal dehiscence. There are no traces of perianth members or bracts. There is a constant association of megasporophylls and fruits with leaves of *Sagenopteris Phillipsi* (Brongn.). The comparative examination of the cuticular structure of the axes of Gristhorpia and Caytonia and of the petioles of Sagenopteris fronds, makes it probable that Sagenopteris must be regarded as the leaf of the Caytoniales.—Winifred **Brenchley** and H. G. **Thornton**: The relation between the development, structure and functioning of the nodules on *Vicia Faba* as influenced by the presence or absence of boron in the nutrient medium. In the absence of boron the vascular supply of the nodule is defective. The strands are often entirely absent, or weakly developed. In plants grown without boron the number of nodules that attain macroscopic size is much reduced. In the nodules without vascular strands, the bacteria do not swell out to form the so-called "bacteroids." When weakly developed strands enter the nodule, the amount of tissue containing bacteroids is closely correlated with the extent of the strands. In the plants bearing these abnormal nodules very little nitrogen is fixed, the quantity fixed per nodule being, in one experiment, less than one-tenth of that fixed in normal plants. In the absence or weak development of vascular strands in the nodule, the bacteria tend to become parasitic. This change in relations between micro-organism and host is connected with loss or reduced supply of carbohydrate energy material normally brought into the nodule by the vascular strands.—A. S. **Rau**, F. W. R. **Brambell** and J. B. **Gatenby**: Observations on the Golgi bodies in the living cell. The so-called "nebenkern" of molluscan germ-cells is the Golgi apparatus, and it can be shown *intra vitam* by Janus green and neutral red. It is visible in fresh cells *intra vitam*, and can be photographed. It stains heavily in the Lewis Janus green-iodine vapour method. The Golgi rods or batonettes are rigid bodies, which retain their shape when released from the cell. Neither the Lewis Janus green-iodine vapour method nor Janus green alone are specific for the mitochondria.—V. **Nath**: Cell inclusions in the oogenesis of scorpions. In forms the oocytes of which contain vitelline yolk there is copious discharge of nucleolar material preceding yolk formation. In other forms the nucleolus remains quite inactive. The Golgi elements in Palamnæus swell up enormously after fragmentation and give rise to yolk (Golgi yolk), which contains free fat like the Golgi yolk of Lithobius (Nath) and *Helix aspersa* (Brambell). The Golgi elements of Euscorpius and Buthus also swell up and form Golgi yolk which, however, retains the same chemical constitution as the Golgi elements. In the centrifuged oocytes of Euscorpius the vitelline yolk is thrown down and the Golgi yolk tends to go towards the opposite pole. The central area is occupied by the granular mitochondria, the unchanged Golgi elements and the nucleus. The mitochondria in all the forms studied are granular and do not take any part in vitellogenesis. Although there is a remarkable disparity, paralleled only in *Paludina vivipara*, in size of the granular mitochondria of oocytes, on one hand, and the very prominent, hollow, vesicular mitochondria of spermatocytes on the other, the vesicular type is only a phase in spermatogenesis.—L. J. **Harris**: The combination of proteins, amino-acids, etc., with acids and alkalis and their combining weights, as determined by physico-chemical measurements.

Physical Society, January 23.—W. **Clack**: An investigation into corrections involved in the measurement of small differences in refractive index of dispersive media by means of the Rayleigh interferometer, with special reference to the application of the results to measurements in diffusion.—B. J. **Taylor** and W. **Clarkson**: A study of the production of "flashing" in air electric discharge tubes. The volt-ampere characteristics for the air discharge tubes is of the general form, $i = k(V - M)$. As in the case of the

"osglim" lamp, there is a critical resistance R_c below which no "flashing" is possible, given by $R_c = E - V_a/\{k(V_a - V_c)\}$.—C. R. **Darling**: A kinematographic study of the formation of Plateau's spherule. Orthotoluidine is allowed to flow slowly into the bulb of an inverted thistle funnel supported mouth downwards in water; when a sufficient body of the liquid has collected, a large drop is formed which gradually changes shape until it breaks away, leaving behind a small secondary droplet known as "Plateau's spherule." Kinematographic study of the breaking process shows that the main drop remains approximately spherical, the liquid to which it is attached extending downwards in a sharply pointed cone attached to the main drop at its point. After breaking away, the main drop falls, oscillating considerably in shape. The rest of the liquid snaps back to form a more or less spherical surface, but the point of the cone is left behind to form the droplet referred to; this is given a slight upward impulse before it also falls to the bottom of the water.

PARIS

Academy of Sciences, December 29.—Ch. **Lallemand**: Concerning the tetrahedral system. Lowthian Green in 1875 suggested that a hollow sphere, submitted to an external pressure, should take a form derived from the tetrahedron. In a recent note Lecornu shows that this view is not supported by a mathematical investigation. Experiments by the author, in 1887, on rubber balloons, and by Ghesquière and de Joly, in 1895, on glass globes softened by heat, are in accord with the tetrahedral theory.—Marcel **Brillouin**: The equations of state of the plastic phase of a solid naturally isotropic.—Gabriel **Bertrand** and M. **Mokragnatz**: The general presence of nickel and cobalt in arable earth. In an earlier communication, the presence of traces of nickel and cobalt in two samples of soil was proved. The analytical method has now been improved, and results of analyses of thirty-three soils from different localities (France, Germany, Denmark, Italy, Roumania) are given. The amounts found, expressed in parts per million of earth, vary between 38·6 and 4·7 for nickel and 11·7 and 0·3 for cobalt. There is always less cobalt than nickel. Dust from interplanetary space is suggested as a possible source of these two metals in arable earth.—André **Blondel**: Certain coefficients of self-induction of alternators.—V. **Grignard** and J. **Savard**: The enolic form of pulegone.—C. **Sauvageau**: Some examples of *hétéroblastie* in the development of some Algæ (Castagnea).—R. H. **Germay**: The integration by successive approximations of systems of partial differential equations of the first order.—Fritz **Carlson**: Integral functions.—S. **Stoilow**: An ensemble where a continued function has a constant value.—Antoine **Lomnicki**: Some generalisations of the arithmetical triangle of Pascal.—L. **Escande** and M. **Ricaud**: Some methods of measuring velocities in hydraulics. The chronophotographic method of measuring velocities, utilising fine powder in suspension, fails when the fluid is in a turbulent state. The substitution of small spheres of density equal to that of the water for the powder gives good results for the mean local velocity. The conditions under which the Pitot tube gives trustworthy measurements are discussed, and a modified method suitable for low velocities described.——**Rateau**: Remarks on the preceding communication.—A. de **Gramont de Guiche**: An acoustic indicator of relative velocity for an aeroplane.—R. **Biquard** and A. **Chenu**: A method for the regeneration of the gas of a balloon, avoiding deflation.—J. **Guillaume**: Observations of the sun, made at the Observatory of Lyons during the third quarter of 1924. Observations of the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude were made on 87 days during the quarter.—A. P. **Rollet**: An electrolytic frequency meter of simple construction. The apparatus is based on the phenomena of successive oxidation and reduction shown by a silver electrode, when the electrolysis takes place in an alkaline solution with a low frequency alternating current.—Albert **Nodon**: Researches on X-rays of long wavelength.—J. H. **Shaxby**: The production of Laue diagrams by means of monochromatic X-rays, and the structure of mother-of-pearl. The mineral part of mother-of-pearl consists of crystals of aragonite, the quasi-hexagonal axis of which is normal to the leaflets.—F. **Croze**. The structure of the line spectrum of nitrogen.——**Lespieau**: The preparation of true acetylene compounds, starting with the mixed magnesium derivatives of acetylene.—H. **Colin** and Mlle. A. **Chaudun**: The hydrolysis constant of sugar. The authors qualitatively confirm the results of Moran and Lewis, and find that the velocity of hydrolysis increases more rapidly than the concentration of the sugar, although quantitatively there is not exact agreement. This increase in the velocity of hydrolysis with sugar concentration is shown to depend on the nature of the acid employed as the catalyst.——**Royer**: The orientation of the crystals of ammonium iodide by muscovite.—G. **Mouret**: The structure of the granitic region of Millevache.—Maurice **Collignon**: The audition of explosion waves at great distances. Deductions from the explosion experiments at Courtine in May 1924.—M. **Coyecque** and Ph. **Wehrlé**: The formations of Hatteras.—Paul **Guérin**: The development of the anther and pollen in gentians.—L. **Léger**: The nutritive value of the snail (*Helix pomatia*). In *Helix pomatia*, in the condition of winter sleep, upwards of 80 per cent. of the fat, and all the glycogen and reducing sugars, are localised in the part usually rejected for food. The snail should be eaten *in toto*.—Alexandre **Lipschütz**: An intersexual malformation in the guinea-pig.—Léon **Blum**, Maurice **Delaville**, and van **Caulaert**: Contribution to the study of the pathogeny of rickets. The essential trouble in rickets is not due to an alteration of the mineral contents of the blood, but in modifications of their physico-chemical state, the latter resulting from an alteration of the acid-base equilibrium.—Marcel **Duval**: The ionic reaction of the blood of some invertebrates.——**Cluzet, Rochaix** and **Kofman**: Variations in the agglutinating power of sera under the influence of the continuous electrical current.—Maurice **Nicloux**: New demonstrations of the normal presence of carbon monoxide in the blood. The presence of traces of carbon monoxide in normal blood has been disputed: from the results of experiments described by the author, the presence of this gas in normal blood is proved.—A. **Malaquin**: The genital glands and primordial sexual cells in the annelid *Salmacina Dysteri*.—Mlle. **Goldsmith**: Light and the symbiotic relations in *Convoluta roscoffensis*.—Constantin **Gorini**: The mammary coccus.—A. **Borrel** and Mlle. **Muller**: Vaccinal virus in the cornea of the rabbit.

January 5.—L. **Lecornu**: The tetrahedral deformation. Remarks on the experiments of M. Lallemand.—W. **Kilian** and G. **Sayn**: The external edge of the subalpine chains to the east of Valence (Drôme) and the breccia of Pialoux.—Paul **Vuillemin**: The *Nématés*, a new division of the animal kingdom.—Jean **Effront**: The absorbing power of agar-agar. Extraction with acid reduces the mineral content of agar-agar, and this demineralised agar does not absorb acid. Pulps from plants, such as beetroot and potato, behave in a similar manner.——**Angelesco**: Certain systems of

biorthogonal functions.—A. **Bloch**: On a circle where a holomorph function takes at least twice the values 0 and 1.—S. **Saks**: A class of interval functions.—J. **Haag**: The experimental determination of the parameter of precision.—A. **Talon**: The piezometric equivalence of the yield of transmission.—W. W. **Heinrich**: New classes of secular solutions of the problem of n bodies.—L. **d'Azambuja**. Observations of mobile masses of absorbing vapour at great heights above the solar surface. Comparison with high protuberances of rapid evolution.—Albert **Pérard**: The refractive index of air, in the visible spectrum, between 0° and 100° C. The apparatus used was that of Benoit, slightly modified. The final result is given by the equation

$$(N-1)10^6 = \left(288{\cdot}02 + \frac{1{\cdot}482}{\lambda^2} + \frac{0{\cdot}0309}{\lambda^4}\right)\left(\frac{h}{760}\right)\left(\frac{1}{1+0{\cdot}003716\,\theta}\right),$$

where λ is the wave-length in microns, θ the temperature in centigrade degrees.—Y. **Rocard**. The diffusion of light in fluids.—Mlle M. **Hanot**: The width of the lines of the Balmer series in the oscillating discharge. For a given initial temperature and pressure, the maximum intensity of the current which traverses a slightly damped oscillating spark determines the width of the lines studied.——**Bayen**: The spark spectra of tungsten and mercury in the extreme ultra-violet.—R. **Jouaust** and P. **Waguet**: The use of the photo-electric cell for certain measurements in industrial photometry. In photometric measurements it is not, in general, possible to replace eye observations by a photo-electric cell, but in certain cases it is possible. One possible application of the cell is the preparation of standard electric lamps, and a description of the method used and precautions necessary is given.—J. **Valentin** and G. **Chaudron**: The solidification of the ternary alloys of aluminium, magnesium, and cadmium.—Édouard **Urbain**: The absorption of vapours by carbon. Defining the "compacity" of carbon as the ratio of the true volume to the apparent volume, absorption curves are given showing the amount of vapours of chlorine, chloropicrin, and benzene absorbed as a function of the compacity. In the case of benzene there is a maximum absorption for compacity 0·3.—Pierre **Auger**: The secondary β-rays produced in a gas by X-rays.—L. **Hackspill** and R. **Grandadam**. The displacement of the alkali metals by iron. At a moderately high temperature, in a vacuum, iron sets free the metals of the alkalies from their hydroxides; in some cases it is possible to collect the alkali metal, in others the presence of the metal can only be proved by the evolution of hydrogen in contact with steam.—Al. **Orékhoff** and Max **Roger**: The semipinacolic deamination of some amino-alcohols. Amino-alcohols of the type $R.R'.C(OH).CH_2(NH_2)$, treated with nitrous acid, give the ketones $R.CO.CH_2.R'$.—Max and Michel **Polonovski**: Oxyeserine and its derivatives.—Marcel **Sommelet**: Researches in the diphenylmethene series. Trimethylbenzhydryl-ammonium bromide.—J. **Grosjean** and M. **Dosios**: The horizon of the Posidonomyes schists containing hydrocarbons of the Toarcian of the Franche-Comté Jura. Analyses of four schists are given, showing yields of oil. Separate analyses of the oils are appended.—E. G. **Mariolopoulos**: The rains sometimes observed with anticyclones.—René **Fabre**: The nature and variations of the aldehyde contained in the blood. There exists in the blood a volatile reducing substance possessing the characters of acetaldehyde.—G. **Mouriquand**, A. **Leulier** and P. **Michel**: Fluctuations of the iron in blood in the course of experimental scurvy.

Official Publications Received.

Anales del Museo Nacional de Historia Natural de Buenos Aires. Tome 31. Pp. iv+678. (Buenos Aires.)

The Journal of the Institute of Metals. Vol. 32. Edited by G. Shaw Scott. Pp. xii+820+37 plates. (London: 36 Victoria Street, S.W.1.) 31s. 6d. net.

University of California Publications in American Archæology and Ethnology. Vol. 21, No. 3: The Uhle Pottery Collections from Ica. By A. L. Kroeber and William Duncan Strong. With three Appendices by Max Uhle. Pp. 95-133+plates 25-40. (Berkeley: University of California Press.) 85 cents.

Crichton Royal Institution, Dumfries. Eighty-fifth Annual Report, for the Year 1924. Pp. 45. (Dumfries.)

Union of South Africa. Department of Agriculture (Division of Chemistry Series No. 51). Science Bulletin No. 35: Profitable Potato Production, Results of a Bethal Co-operative Experiment. By Thos. D. Hall. Pp. 14. (Pretoria: Government Printing and Stationery Office.)

Annals of the Natal Museum. Edited by Dr. Ernest Warren. Vol. 5, Part 2, January. Pp. 101-284+plates 8-14. (London: Adlard and Son and West Newman, Ltd.) 15s. net.

Proceedings of the American Academy of Arts and Sciences. Vol. 59, No. 16, December: The Bodily Proportions of Women in the United States; based upon Measurements taken from one hundred Smith College Students. By Dr. Harris Hawthorne Wilder and Margaret Washington Pfeiffer. Pp. 439-503. (Boston, Mass.) 4.25 dollars.

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 50, Part 1, January. Pp. 172+lxxvii. (London: Vincent Square, S.W.1.) 7s. 6d.

Royal Horticultural Society. Notices and Arrangements for the Year 1925; Report for the Year 1924, with Statement of Accounts; List of new Fellows; Horticultural Advertisements. Pp. 167+lxxvii. (London: Vincent Square, S.W.1.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Extracted from Year Book No. 23, for the Year 1924.) Pp. 145-186. (Washington.)

Proceedings of the Edinburgh Mathematical Society. Edited by Dr. Archibald Milne and Dr. T. M. Macrobert. Vol. 42 (session 1923-24), Part 2. Pp. 61-112+viii. (London: G. Bell and Sons, Ltd.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 11, Part 1: The Sphegidæ of South Africa. By Dr. George Arnold. Part 5: On Cynodontia from the Middle Beaufort Beds of Harrismith, Orange Free State; On a new Type of Thecodont from the Middle Beaufort Beds. By Dr. S. H. Haughton. Pp. 97+8 plates. (Cambridge: Printed at the University Press.)

Armstrong College, Newcastle-on-Tyne. Standing Committee for Research. First Annual Report, 1923-4. Pp. 12. (Newcastle-on-Tyne.)

Proceedings of the Society for Psychical Research. Part 92, Vol. 34, December. Pp. 201-341. (London: Francis Edwards.) 9s. net.

Diary of Societies.

SATURDAY, FEBRUARY 14

ROYAL INSTITUTION, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (I.).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir D'Arcy Power: Hunterian Oration.

INSTITUTION OF STRUCTURAL ENGINEERS (Western Counties Branch) (at Royal Institution, Swansea), at 6.—G. B. R. Pimm: Piles and Pile Foundations.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Municipal College of Technology, Manchester), at 7.—W. H. Meadowcroft: Some Foundry Experiences.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Loughborough Technical College), at 7.10.—Loughborough Graduates' Meeting.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—V. C. Faulkner: Some Notes on Refractory Materials.

MONDAY, FEBRUARY 16

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. P. G. Wakeley: The Etiology, Pathology, and Treatment of Ectopic and Imperfect Descent of the Testis.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Dr. L. Williams, Col. R. McCarrison, Dr. W. Cramer, Dr. G. M. Findlay, and others: Special Discussion on Non-Specific Disturbances of Health due to Vitamin Deficiency.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—F. G. Woollard: British Methods of Continuous Production.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—A. D. Young: The Design and Construction of the No. 5 Gas Holder for Burnley Corporation.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scotland Centre) (at Royal Technical College, Glasgow), at 7.30.—C. H. Macmillan: Marine Motor Installation.

BRITISH ASSOCIATION OF CHEMISTS (Birmingham Section) (in Medical Theatre, Birmingham University), at 7.45.—Dr. F. W. Aston: Atomic Weights and Isotopes.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—D. S. McColl: Sculpture in relation to Architecture.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. J. Drever: The Meaning of Consciousness for the Psychologist.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (Cantor Lectures) (I.).

FARADAY SOCIETY (at Chemical Society), at 8.—Prof. A. J. Allmand and V. S. Puri: The Effect of Superposed Alternating Current on the Anodic Solution of Gold in Hydrochloric Acid.—Prof. C. H. Desch and

Eileen Vellan: The Electrolytic Deposition of Cadmium and other Metals on Aluminium.—W. M. Thornton and J. A. Harle: The Electrolytic Corrosion on Ferrous Metals.—S. Glasstone: Overvoltage and Surface Forces at the Lead Cathode.—M. Shikata: The Electrolysis of Nitrobenzene with the Mercury-dropping Cathode.—J. R. Coutts: The Law of Distribution of Particles in Colloidal Suspensions: A Note on the Specific Volume of a Gamboge Suspension.—W. W. Barkas: The Distribution of Particles in Colloidal Suspensions.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School, Cambridge), at 8.45.—Prof. D. M. S. Watson: Orthogenesis.

MEDICAL SOCIETY OF LONDON, at 9.—Sir Bernard Spilsbury: Wounds and other Injuries (Lettsomian Lectures) (I.).

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court).

TUESDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (II.). The Colour of the Hare.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—E. J. Russell and T. Ediser: The Fishery Statistics of England and Wales.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions made to the Society's Menagerie during the month of January 1925.—Major S. S. Flower: Contributions to our Knowledge of the Duration of Life in Vertebrate Animals.—I. Fishes, II. Batrachians.—R. I. Pocock: (*a*) The External Characters of an American Badger (*Taxidea taxus*) and an American Mink (*Mustela vison*) recently exhibited in the Society's Gardens; (*b*) Additional Notes on the External Characters of some Platyrhine Monkeys.—Dr. R. Broom: The Origin of Lizards.—A. Loveridge: *Natrix alliaceus* Peters (Reptilia), from Pemba Island, and other Notes.—E. P. Allis, jun.: The Origin of the V-shaped Branchial Arch in the Teleostomi.

INSTITUTION OF ELECTRICAL ENGINEERS (North Western Centre) (at Engineers Club, Manchester), at 7.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—C. F. Elwell: The De Forest Phonofilms.

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (at 36 York Place, Edinburgh), at 7.30.—T. Bolam, W. O. Kermack, W. T. H. Williamson, and others: Discussion on The Stability of Colloids.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Freemasons' Hall, Edinburgh), at 7.45.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—R. A. Bellwood: The Romance of the Vegetable Oils.

WEDNESDAY, FEBRUARY 18.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield), at 2.30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. Scott Williamson: The Anatomy and Physiology of the Thyroid Apparatus (I.).

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (jointly with the Liverpool Geological Society) (in Chemistry Department, Liverpool University), at 6.—Prof. P. G. H. Boswell: Mineral Oil: Supplies of the Present and Future.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—R. H. Tangri: Reconstruction of Barrow Haven Bridge, Lincolnshire, L. and N. E. Ry.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates' Meeting) (at Chamber of Commerce, Birmingham), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College), at 7.30.—Prof. H. V. A. Briscoe and P. L. Robinson: A Redetermination of the Atomic Weight of Boron.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—W. B. Woodhouse: Presidential Address.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Miss L. Doris Sawyer: The Effect of Pressure Distribution upon London's Sunshine in Winter.—Prof. S. Chapman: On the Changes of Temperature in the Lower Atmosphere, by Eddy Conduction and otherwise.—N. K. Johnson and C. F. T. Roberts: The Measurement of the Lapse Rate by an Optical Method.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. S. Owens: Modern Atmospheric Conditions.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY.—J. M. Hill: Primitive Medicine and Folk-lore of the Guiana Indians.

THURSDAY, FEBRUARY 19.

MEDICO-PSYCHOLOGICAL ASSOCIATION (at Royal College of Physicians, Edinburgh), at 2.30.—Dr. D. Slight: The Psycho-galvanic Reaction.—Dr. G. Gibson: The Boarding out System.—Dr. W. M. McAlister: Results of Treatment of General Paralysis by Malaria.

ROYAL SOCIETY, at 4.30.—Prof. O. W. Richardson and A. F. A. Young: The Thermionic Work-Functions and Photoelectric Thresholds of the Alkali Metals.—J. H. Brinkworth: The Measurement of the Ratio of the Specific Heats using Small Volumes of Gas.—F. H. Constable: The Catalytic Action of Copper: Parts VI. and VII.—V. H. Stott, Edith Irvine, and D. Turner: Viscosity Measurements of Glass.—*To be read in title only*.—W. G. Palmer and F. H. Constable: The Catalytic Action of Copper: Part V.—P. A. M. Dirac: The Adiabatic Invariance of the Quantum Integrals.—D. L. Watson: The Thermal Decomposition of Derivatives of Oxalacetic Ester.—A. Unimolecular Reaction.—K. R. Rao: (1) The Fluorescence and Channelled Absorption of Bismuth at High Temperatures, (2) A Note on the Absorption of the Green Line of Thallium Vapour.

LINNEAN SOCIETY OF LONDON, at 5.—Miss A. Lorrain Smith: John Templeton's Drawings of Lichens and Fungi.—Dr. J. Burtt-Davy: The Tropical African Element in the Arborescent Flora of the Transvaal.—Prof. R. R. Gates: Virescent Inflorescence of Delphinium.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Properties and Structure of Quartz (IV.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. M. Alexander: An Unrecognised Principle in Human Behaviour.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Major E. I. David: Electricity in Mines.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 7.—Lt.-Col. L. F. R. Fell: Light Aeroplane Engine Developments.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—W. E. Bush: Modern Electric Lighting Practice.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates' Meeting) (at Cavendish Café, Derby), at 7.30.—R. Bolton: The Early History of Road Transport.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 7.45.—Dr. H. Melenev: Demonstration on the Pathology of Experimental Leishmaniasis in the Hamster.—At 8.15.—Prof. B. Blacklock: Schistosomiasis and Goitre in Sierra Leone.

CHEMICAL SOCIETY, at 8.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—Prof. E. C. C. Baly: Photosynthesis of Naturally Occurring Compounds.

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY OF LONDON, at 8.—Annual General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. Scott Williamson: The Anatomy and Physiology of the Thyroid Apparatus (II.).

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Discussion.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at City Council Chamber, Birmingham), at 7.—W. B. Woodhouse: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. C. Banfield: Photography by Artificial Light.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. N. Seddon: Inverted Tooth Chain Drives.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. H. Pear: Acquiring Muscular Skill.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at 36 George Street, Manchester).—D. A. Gibbens: Some Work done in the Chemical Department of the Shirley Institute.

INSTITUTION OF ENGINEERING INSPECTORS.—Major C. E. S. Phillips: The Radium Industry.

SATURDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (II.).

PHYSIOLOGICAL SOCIETY (at London School of Medicine for Women).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. Lovett: Natural History in Folk-lore.

MONDAY, FEBRUARY 16.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE, at 5.—Sir William I. de Courcy Wheeler: Some Practical Considerations and Experiences in the Conservative Treatment of Fractures of the Pelvis and the Lower Extremity (I.). (Succeeding Lectures on February 17, 18, 19.)

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: Organising an International Civil Service for Purposes of Industrial Research.

UNIVERSITY OF LEEDS, at 5.15.—Dr. H. H. Dale: Anaphylaxis.

MEDICAL SOCIETY OF LONDON, at 5.15.—Prof. E. W. Hope: International Hygiene (Chadwick Lecture).

BIRKBECK COLLEGE, at 5.30.—Dr. G. G. Coulton: Medieval Education (III.). Spoken Latin in the Middle Ages.

KING'S COLLEGE, at 5.30.—Prof. A. E. Jolliffe: English Mathematics before Newton.

TUESDAY, FEBRUARY 17.

KING'S COLLEGE, at 5.30.—Miss Evelyn Underhill: The Realism of the Mystics.

UNIVERSITY COLLEGE, at 5.30.—Prof. J. E. G. de Montmorency: The Significance of the Humanism of the Negro Races.

GRESHAM COLLEGE, at 6.—Sir H. Walford Davies: Music. (Succeeding Lectures on February 18, 19, 20.)

UNIVERSITY OF LEEDS, at 8.—Prof. J. H. Priestley: Moorland Plants.

WEDNESDAY, FEBRUARY 18.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—J. Thorp: The Principles of Design as applied to Books and Printing.

KING'S COLLEGE, at 5.30.—Baron A. F. Meyendorff: Travels in the East. A.D. 800–1200.

UNIVERSITY COLLEGE, at 5.30.—A. Gomme: Technical and Scientific Libraries.

THURSDAY, FEBRUARY 19.

KING'S COLLEGE, at 5.30.—Dr. I. P. Bruce: Education in China.

CENTRAL LIBRARY, 598 Fulham Road, at 8.—A. J. Linford: England's Story in Stone.

SATURDAY, FEBRUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour Browne: My Journey to Brazil.



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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2886, VOL. 115]

Words, Meanings, and Styles.

I.

FOR several weeks various opinions have been expressed in our correspondence columns as to the desirability or otherwise of using the word scientist to designate in a generic sense any one actively engaged in the advancement of natural knowledge by investigation. The term is not an Americanism, as is often supposed, but was introduced by Dr. Whewell in 1840 "to describe a cultivator of science in general." In a letter published in NATURE of November 29, Dr. Norman Campbell pleaded for approval of the word, and asked objectors to suggest a single substitute for it if they were not willing to adopt it. We invited opinions upon the question from a number of distinguished representatives of letters as well as of science, and have published some of the replies with which they have favoured us. The general attitude of scientific workers was clearly stated by Sir Ray Lankester in our issue of December 6; and it is one of dislike. Literary authorities, on the other hand, are prepared to give the word a legitimate place in the English language, and they point to many similar hybrids which have been admitted into our vocabulary without question.

It cannot be said that, as the result of the discussion, any single word has been suggested which is likely to come into general use as a substitute for scientist. Some of our correspondents have expressed complete abhorrence of this term, others have given unwilling acceptance to it, and a third group approves of it. While, therefore, we do not propose to depart from our custom of avoiding the word in our own practice, or in unsigned contributions for which we accept editorial responsibility, we are content to leave individual authors to use it or not, as they may prefer. Our opinion is that one of the main objections to the word is that it is too comprehensive in its meaning. Sir Israel Gollancz thinks the word should not be limited to workers in the field of physical or biological science, and Prof. Wildon Carr would make it imply philosophers as well as such workers. What they apparently desire is a word which is equivalent to the French savant or the German Gelehrte, but it can scarcely be said that the term scientist was coined with this intention.

The fact is that, in these days of specialised scientific investigation, no one presumes to be "a cultivator of science in general." A man is a chemist, physicist, biologist, botanist, or worker in one or more particular branches of science, and he prefers to be designated as such rather than to be placed in an indefinite group of "scientists." In an artificial language like Esperanto, it is easy to assign a single termination, such as "ist," to all professional occupations, but no hard and fast rule of this kind can be imposed upon the structure

of a living language. Certain words come into use, while others are discarded, and no purely logical or etymological plan of formation is practicable. "Mathist" and "electrist" may, as Sir Richard Paget suggests, be improvements upon "mathematician" and "electrician," and Prof Armstrong's "sciencer" may be a suitable substitute for the word "scientist," but whether the termination be "ist" or "er," custom alone will decide which will survive. We have geographer and geologist, engineer and technologist, philosopher and physicist, astronomer and spectroscopist, all in common use, whether rightly or wrongly formed. The public has similarly accepted "scientist" to signify a follower of science of any kind, and will continue to use it even though it is not approved as good currency in the scientific world.

An inquiry of the secretaries of the leading British scientific societies shows that the word is very rarely used in their publications and is always avoided when it can be conveniently avoided It is not used officially by the Royal Society of London or of Edinburgh, the British Association, or the Royal Institution, and each of these bodies often has occasion to refer to workers in science as a whole. The feeling of the Cambridge University Press is strongly against the use of the word scientist, and when, in one instance, it occurred in the title of a work submitted to the Syndics, a strong protest was raised and the title of the book was altered On the other hand, the Clarendon Press, Oxford, does not object to the word being used in its books, and says: "Of course we avoid any attempt to legislate and are guided principally by usage." There is no doubt whatever that the balance of feeling in scientific circles is against the word. Whatever its future, therefore, we are not prepared to depart from our practice hitherto of avoiding the word, and we leave it to others to convert it into the currency of cultured usage.

The variety of opinion on the recognition of the word scientist enables a conception to be formed of the labour involved in providing a good technical vocabulary for a new subject such as aeronautics. There is, first of all, the difficulty of setting up a systematic nomenclature with reasonable claims to be logical without being pedantic. In addition, there is the still greater difficulty of obtaining general acceptance by such diverse people as mathematical physicists, technical engineers, constructors, pilots, mechanics, the Services, and last, adoption by the press, most influential of all. The Technical Terms Committee of the Royal Aeronautical Society, which was reconstituted in 1920 as a section of the British Engineering Standards Association, produced the present officially accepted glossary for aeronautics; and the Advisory Committee for Aeronautics in the U.S.A. has shown much broad-mindedness in adopting the great majority of the British findings. There are important exceptions, however. Dr. Alexander McAdie, director of the Harvard meteorological station at Blue Hill, in writing to us about the word scientist comments on the continued use of the form "aeroplane" in Great Britain, replaced by "airplane" in America.

Generally speaking, it will be found that, in the official glossary for aeronautics, *air-* is compounded with common English words, or with words derived through the French language, while *aero-* is compounded with technical terms of direct Latin or Greek origin. Thus: *Air- man, ship, craft, shed, screw*, but *aero- stat, naut, bate, dynamics*, etc. *Aerofoil* is an exception and should be either *airfoil* or *aerofolium* *Aeroplane* is right by the rule, but *seaplane*, introduced by the Admiralty during Mr. Churchill's regime, and *landplane, floatplane, wheelplane* proposed but not yet accepted, all justify *airplane* *Airplain* is ruled out by the lack of association of *plain* with wing-like structures; but the influence of the French word *aéroplane*, the interest vested in the title of our own liveliest of technical periodicals, and ingrained use, will prevent the giving up of the form *aeroplane* for a long time. A very stout battle has been fought over the introduction of *air-screw* to avoid such combinations as *tractor propeller* and *pusher propeller* which are retained in the U.S.A. vocabulary. The most awkward gap in the language of aeronautics is due to the want of words to denote aircraft both lighter than air and heavier than air. *Aerodyne* was proposed by analogy with *aerostat*, but nothing more has been heard of it, *H/A craft* and *L/A craft* beg the question, and it may be hoped that *lighter-than-air-craft* will not survive. In the face of these few examples of the difficulties which crop up in a technical vocabulary, it is a bold prophet who will predict the terms around which the language will finally crystallise.

In discussing the use or disuse in English of any particular word, the very mixed origin of our language must, of course, be borne in mind. Anglo-Saxon, Latin and Greek have all provided roots which appear in words in general use, while, if the vocabularies of the sciences and arts are taken into consideration, it is clear that a much wider range of languages has also been used. This may perhaps account for the ease with which foreign words are introduced, often as slang at first, and eventually adopted, with little if any change in spelling. It should also incline us to be tolerant of hybrid words, though, of course, the making of new hybrids, unlike the work of the plant-breeder, cannot be expected to be productive of beauty and increased usefulness, and should be discouraged.

The question is discussed in an interesting article

by Mr. George H. Bonner in the December issue of the *Nineteenth Century*. The real point is this: A word having crept into use, what is to be the ultimate authority for discarding or retaining that word as a definite part of the English language? In France the decision is in the hands of the Academy. A word is "adopted" or otherwise and the writers of the day follow, more or less, the recommendations made. But that will not prevent the use of a word in conversation and by the general public. After all, it is the growth of popularity of a word which is a factor in bringing it to the notice of the Academy. If a new word is useful in that it conveys an exact meaning not readily expressed in a word or concise phrase at present accepted as legitimate, it would seem that popular usage will gradually enforce its adoption. Thus the vocabulary of a language, if it is to meet the demands made upon it by a progressive people, must be continuously in a state of flux.

This may explain, in part, why so little progress has been made in the adoption of an international language Apart from the claims of nationalism, which have been increasingly insistent during the past few years, "living" languages must, with the growth of new ideas and the introduction of foreign elements, be always developing. It therefore becomes difficult for those who are not, as it were, "living with the language," to keep pace with changes of meaning. As regard purely artificial languages, the question of following the dictates of an academic central authority again arises. The authority, in most cases, will trail behind popular usage.

There is, however, a further consideration, as Mr. Bonner points out in the article to which we have referred. The language of conversation is not normally the language of serious writing In talking, the periods are generally comparatively short and the argument often gains by the use of terse and incisive expressions which would be totally out of place in written contributions. When it is a question of placing on record, for serious discussion and reflection, facts and thoughts which represent additions to the sum of human knowledge, then accuracy of meaning and dignity of expression should be the rule. Here again, in English, popular usage would seem to be the ultimate authority, though with the restriction that "popular usage" should refer to the diction and style of the better educated and more intellectual of the community. The language of a progressive people must itself be progressive; and as the word scientist expresses more clearly and with less ambiguity than any other single word the meaning it is intended to convey, it is likely to survive the dislike which scientific workers in general have for it.

Continental Drift.

The Origin of Continents and Oceans By Prof. Alfred Wegener. Translated from the third German edition by J G A. Skerl. Pp. xx + 212 (London: Methuen and Co., Ltd., 1924.) 10*s* 6*d*. net.

THE wide appeal of Prof. Wegener's theory of the arrangement of ocean and continent is shown by the issue of a third greatly revised edition and of this excellent English translation. His theory is that the continents consist of rigid blocks of sial, or rock characterised by a high percentage of silica and alumina, which are floating partly submerged in a sheet of sima, or rock material composed mainly of silica and magnesia; that the existing continents are due to the breaking up of a once continuous sheet of sial, the fragments of which have drifted to their present positions in consequence of the earth's rotation; and that this drift occurs owing to the plasticity of the sima Prof. Wegener believes that the continents have been moved for great distances even in geologically recent times, and he thereby, with great ingenuity and attractiveness, explains many problems of geography, geology, climatology, biology, and geodetics The process offers an easy escape from difficulties and is not to be dismissed as impossible or scouted as fantastic, for in all probability sima is more plastic than sial, and the rotation of the world must make the continental masses tend to lag westward, and press centrifugally toward the equator The view that the continental masses are subject to some horizontal drift has been often adopted, as, for example, by the reviewer in 1915 (*Scot. Geog. Mag.*, 31, pp. 258-60) to explain the folded nature of the Pacific margin of America, in contrast to the coastal structure on both sides of the Atlantic, and the prevalence of fiords on western coasts. There is no *a priori* objection to the principle, and the verdict on Prof. Wegener's theory will depend on whether it explains more difficulties than it creates.

The author's interesting discussion of the geophysical arguments shows that on this branch of the subject the primary facts are still uncertain In spite of the apparent precision of mathematical methods, the data are so inexact that the results are inconclusive. Prof. Wegener's theory will, however, probably give a new lease of life to the explanation of the Carboniferous glaciation of India and of some parts of the Southern Hemisphere, by the shifting of the Pole; for arguments, which are unanswerable against that explanation with scattered continents, do not apply to Prof. Wegener's single continent.

The theory of continental drift was suggested by that coincidence in course of the opposite coasts of the

Atlantic, which is one of the best known of the geographical homologies. Its significance was remarked by Bacon. Prof. Wegener has the advantage over Lord Bacon that the geological evidence now supports the inferences from geographical shape; for the opposite parts of the Atlantic show remarkable resemblances in structure and composition. The agreements, according to Wegener, are due to the coasts having been originally in contact, and having been separated by a curved fracture which was widened into the Atlantic basin, owing to the land west of the rift having drifted away as America. The agreement in grain of the lands on the two sides of the Atlantic is, however, also capable of explanation by vertical movements of the crust If two pieces of wood with the grain of each in line are seen in a sheet of water, it does not follow that they were originally in contact and have floated apart. They may be the ends of a warped plank, of which the middle has sunk beneath the surface. The Appalachian and Armorican Mountains may have belonged to a continuous mountain belt without their having been actually adjacent, just as the Pyrenees and the Caucasus are regarded as part of one mountain system although they have always been separated by the full width of Europe. In fact, the differences between the Appalachians and the corresponding mountains in Western Europe indicate that they were probably formed some distance apart The problem is whether the corresponding structures on opposite sides of the Atlantic have been separated by a two-mile subsidence of the intervening area, or by the horizontal drift of America for 2000 or 3000 miles.

Individual judgments on this question depend upon the theory accepted of the structure of the earth; and long before any agreement is reached by this route, the displacement theory should be proved or dismissed by direct observation According to Prof. Wegener, southern Greenland is moving away from Scotland at the rate of from 18 to 36 metres a year, and Iceland is drifting away from Norway from 18 to 19 metres a year. The estimate for Greenland rests on the difference of longitudes determined by the *Germania* expedition of 1870 and the Danish expedition of 1907; they were determined by lunars and are not convincing. Wireless determinations of longitude at intervals of five or ten years should soon provide an absolute test of the theory, as is remarked by Dr. Evans in his interesting introduction to the volume.

The movement in the central Atlantic is regarded as slower than in the north, yet as increasing the distance between Brazil and the Cameroons eight inches a year. The growth of the tropical Atlantic, according to Prof. Wegener's table, has taken about 20 million years, though at the rate of drift assigned to Brazil, the time should have been 40 million years; therefore, according to the geological dates accepted on p. 113, the formation of the tropical Atlantic began in the early Mesozoic. The westward drift of South America is regarded as a long-continued process, and its crumpling effect on South America should have been widespread and continuous. The folding of the Andean belt was intermittent and happened at distant dates; but the folding that made the existing Andes happened in a relatively short period. That condition is consistent with the explanation of the Andean folding by a western lag which has been previously referred to, as the lag was attributed to instability due to vertical movements in the crust at one geological period; but without some acceleration of the westward movement in the middle Kainozoic, Wegener's continental drift does not explain the formation of the western fold mountains of America. Moreover, as the author shows in the fifth chapter from the palæontological evidence, the land connexion across the Atlantic was established and broken several times; so the displacement theory requires a concertina-like movement, America being pushed first west and then east. A vertical oscillation of the crust presents no difficulty comparable to that of an oscillatory horizontal passage of the Americas to and fro across the Atlantic.

A horizontal oscillation of even that amount is, however, insufficient. The displacement hypothesis is advocated from biogeography on, amongst other grounds, the occurrence on both sides of the Atlantic of animals and plants which apparently crossed it in about their present latitudes, and that shallow water marine animals, to which the deep seas are almost as impassable as to land animals, show the former range of shallow water along the same zones. The argument based on the marine animals appeals to the reviewer as one of his earliest papers urged it from the evidence of the fossil Echinoidea. Prof. Wegener quotes the manatee, which lives in the estuaries of West Africa and South America and is not likely to have crossed an ocean so wide as the Atlantic There is, however, similar evidence of land connexion across the Pacific. The alligator is now found only in the Yangtze Kiang in China, and in the warmer parts of America; and it is no more likely to have crossed the open ocean or rounded the Pacific by Bering Straits than the manatee is to have crossed the Atlantic via Iceland and Greenland. Some lizards, amphibians, and the main flora of China support the evidence of the alligator as to a former land route across the Pacific to America. It is, however, essential to Prof. Wegener's case that Western America and the eastern lands of the Old World should have been previously farther apart than they are to-day; for before the separation of the Americas from Europe

and Africa the Pacific must have been wider. Prof. Wegener remarks (p. 86) that some of the earthworms of Australasia and New Zealand not only reach India but also, "strange to say, occasionally the west coast of North America."

This range of Australasian worms to western America is one item in a mass of biological evidence inconsistent with the view that America has been drifting westward into the Pacific. For example, Pritchardia, the characteristic palm of the south-western Pacific, is known elsewhere only in the Sandwich Islands and in Cuba, where its unexpected occurrence was attributed by Beccari to its fruits having been hurled from Polynesia by a volcanic eruption. According to Dr. Scharff, one element in the flora of the islands off western Mexico represents the eastern range of a central Pacific flora which was partly of Australasian and Eastern origin. Similarly, according to Pilsbury, the distribution of the land shells demands radial migration from a central Pacific land. Its existence is also indicated by the coral islands and by the contours of the Pacific floor.

The existence of a land connexion from America westward across the Pacific is, however, wholly inconsistent with the present form of the displacement theory. If the pilgrims had been rafted across the Pacific on migrating lands, America, after its separation from the western side of the Old World, not only drifted westward until it bumped against eastern Asia, but also has floated back to its present position. Unluckily for this explanation, the trans-Pacific and trans-Atlantic connexions are required at about the same time. Hence it would be necessary to assume that the sial mass of America at one time lost its rigidity and, like a rubber bladder, spread out as a thin sheet over both the Atlantic and Pacific basins; and that afterwards it contracted and thickened to form a meridional bolster. The original theory has undergone so many modifications, and its author is so delightfully open-minded, that it may be changed to agree with a trans-Pacific land connexion. The theory at present is inconsistent with so many facts that Prof. Wegener's calculation, that the odds based on the grain of the Atlantic shores are a million to one in his favour (p. 56), do not hold for the whole of his case.

The favourable reception of Prof. Wegener's theory is significant of marked changes of opinion as regards the structure and history of the earth. It shows that the once widely adopted view that oceans and continents have always been in their present positions no longer hampers geological interpretation, and it marks the growing belief in the effective mobility of the earth's crust.

J. W. GREGORY.

Greek Alchemy.

Union Académique Internationale. Catalogue des manuscrits alchimiques grecs. 1: Les *Parisini*. Décrits par Henri Lebègue. En Appendice, Les manuscrits des *Coeranides* et tables générales, par Marie Delcourt. Pp. x+320. n.p. 3: Les manuscrits des Îles Britanniques. Décrits par Dorothea Waley Singer, avec la collaboration d'Annie Anderson et William J. Anderson En appendice, Les recettes alchimiques de *Codex Holkhamicus*, éditées par Otto Lagercrantz. Pp. vii+84. n p. (Bruxelles: Maurice Lamertin, 1924.)

NO one who has not himself rummaged among the old chemical manuscripts in the great libraries can have any idea of the vast quantity of material which awaits investigation. Even the printed literature of the fifteenth to seventeenth centuries has been by no means fully studied, but of the earlier manuscript material only a fraction has hitherto been examined. This neglect is reflected in our histories of chemistry, which commonly begin seriously with Priestley and Lavoisier, by whose time chemistry was already well established on lines not widely different from those of to-day. The earlier periods are usually dealt with very summarily, since to give an adequate account of them, in the present state of our knowledge, would entail years of laborious work upon the original sources. The very ideas themselves, from their unfamiliar nature, often seem entirely unintelligible.

Any contributions, however small, to the accomplishment of the task presented to us by this unstudied material would therefore be certain of a warm welcome. When, however, they are of the standard and magnitude of the "Catalogue des manuscrits alchimiques grecs," it becomes difficult to express our thanks adequately. For our knowledge of Greek alchemy we have had to rely practically entirely upon the work of Berthelot and his collaborator Ruelle, whose "Collection des anciens alchimistes grecs" (3 vols., Paris, 1888) has been almost the sole source of our information on this subject. The recent revival of interest in the history of science has rendered it desirable to extend and amplify our knowledge of early chemistry, and it was very necessary to make a systematic investigation of all the extant manuscripts. Bibliographical research of this nature confers an inestimable boon upon later workers in the field, for it shows them at once what is and what is not available, and saves them more time than can readily be appreciated except by one who has suffered from the lack of such information.

That the present work is published under the direction of Profs. Bidez, Cumont, Heiberg, and Lagercrantz,

is a sufficient indication of its comprehensiveness and trustworthiness, two qualities which in an undertaking of this kind are absolutely indispensable. Unless one can be perfectly certain that a bibliography is full and accurate, one always has the uneasy feeling that something of importance may have been overlooked, and there is nothing more depressing.

Parts 1 and 3 of the Catalogue—all that are published so far—deal respectively with the Greek alchemical manuscripts in Paris and those of the British Isles. The first part, which is the work of M. Henri Lebègue, includes also a description of the MSS of the Koeranides by Mdlle M. Delcourt, who provides, in addition, comprehensive indices to the whole volume On the Koeranides or Kiranides—a work on the virtues of plants and animals—reference may be made to Thorndike's "History of Magic and Experimental Science," 1923, ii. ch. xlvi., and to Ruelle's "Lapidaires grecs," Paris, 1898. The Greek alchemical manuscripts at Paris are 19 in number. They are carefully described folio by folio, in such a way that a good idea is given of the whole contents When they have been edited, references are given to the edition Scholars, therefore, who desire information on the MSS. will find, ready to hand, all that is necessary to enable them to form a judgment

The third part, which deals with the manuscripts of the British Isles, is on similar lines It includes also two papyri, one at the British Museum (Papyrus 121) and one in the Bodleian [MS. Gr. f. 73 (p) 3396]; a manuscript of the Koeranides; and the text of the Byzantine Greek manuscript on alchemy (290, ff 186-194) preserved in the library of the Earl of Leicester at Holkham Hall. The last section is the work of Prof Otto Lagercrantz, the main portion of Part 3 was compiled by Mrs. Singer, with the collaboration of Miss Annie Anderson and Mr. W. J Anderson Mrs Singer's catalogue of the scientific manuscripts of the British Isles now includes about 40,000 items, and the present catalogue is the development of one of the sections of the general catalogue. Those who have had the privilege of using the latter—a courtesy which Mrs. Singer extends with unfailing generosity to all scholars—fully realise the tremendous assistance it will give to historical research in science, and will rejoice that this part of it is now in print.

The general impression gained from a perusal of the two parts is one of astonishment at the comprehensiveness of Berthelot and Ruelle's work. As M. Bidez says, "If the faults of Ruelle's work have become apparent, it is the result of a new scientific curiosity which he was one of the first to awaken." We cannot doubt that the publication of the present Catalogue will stimulate research into the origin of chemistry; it will certainly render the task of workers in this field very much easier. It is, moreover, not without interest to Hellenists themselves, for surely no student of Greece can afford to neglect this early scientific or quasi-scientific literature.

The important Holkham Hall manuscript, which, at Sir Frederick Kenyon's request, the Earl of Leicester kindly allowed to be published, was brought to light by Prof. Cumont It has here been edited, with an introduction and critical annotations, by Prof. Lagercrantz It is entitled "τῆς ἀλτεμίας ἡ διαταξις καὶ ἡ συμβολὲς καὶ ἡ κόπρωι—alchimiae apparatio et compositiones et fimi"—and is interesting not only because of the strange substitution of ἀλτεμία for ἀλχημία or ἀλχυμία (a point which Prof. Lagercrantz discusses in his preface), but also because it shows that the Byzantines had original views on alchemy and did not confine themselves to reading and interpreting the works of the ancient Greek alchemists. We hope that it may prove possible to publish a translation of this MS into English, French, or German, and so to make it more easily accessible.

E. J. HOLMYARD

Our Bookshelf.

Introduction to the Theory of Spectacles. By Prof. Dr. Otto Henker Translated by R Kanthack. Pp. viii+336. (Jena: School of Optics; London: J W Atha and Co., 1924.) 13*s.* 6*d.*

THE book under notice follows the lines of Prof. Henker's courses of lectures on spectacles; the German edition from which the present translation by Mr Kanthack is made was first published in 1921. Commencing from elementary principles, it gives an account of modern continental practice in spectacle optics, embodying the important work (in connexion with cataract lenses, telescopic spectacles, and other special aids to vision) of the Jena school under Prof. Moritz von Rohr. This has been mainly accomplished since the year 1908 While the War with its immense number of special cases of injuries to the eye undoubtedly gave a renewed stimulus to studies of this kind, many sufferers are still (as Prof. Cheshire points out in a foreword) ignorant of the aid which science can now give them. The present book should fill a great need if it gives information of this kind.

The mathematical theory goes no further than the usual Gaussian first-order treatment, but aberrational defects and means of overcoming them are explained with the aid of diagrams. The analogy between the action of the anastigmatic spectacle lens (with its stop at the centre of rotation of the eyeball) and the single photographic landscape lens, in securing freedom from the astigmatism of oblique pencils, emphasises the fact, not yet sufficiently appreciated, that a spectacle lens must be designed with the same understanding and similarly thorough analytical and trigonometric methods as for any other optical instrument. As

Gullstrand pointed out, such anastigmatism cannot be secured in high-power cataract lenses without the use of non-spherical surfaces. The design of such lenses by Prof. von Rohr and their production by Zeiss is one of the most interesting matters dealt with in the book. The importance of this work to ophthalmological science cannot be too fully emphasised.

A number of terms and phrases are found which should not be adopted in Great Britain without question. There are good reasons against the term "point-focal" as applied to any lens whatever, and there is no need to replace the familiar term "bending" (as applied to a lens) by "co-flexure." Other examples will be found

The number of tables and charts which the book contains render it in fact a very useful work of reference for the ophthalmologist, though it is undoubtedly more than an "introduction to the theory of spectacles"; its scientific importance is unquestionable.

The British Journal Photographic Almanac and Photographer's Daily Companion; with which is incorporated "The Year Book of Photography and Amateurs' Guide" and "The Photographic Annual," 1925 Edited by George E Brown Sixty-fourth issue. Pp 816. (London: H. Greenwood and Co., Ltd, 1925) Paper, 2s net; cloth, 3s net.

THIS almanac continues to occupy the unique position that its editor has earned for it, and to have lived down all its previous contemporaries. Its general character is too well known to need description, and is maintained in the present volume, but a few welcome changes have been introduced. The most notable of these is the replacement of the tables of chemical formulæ by a series of short articles dealing with the properties of the commonest of the chemical substances used in photographic processes. These will be found of real practical utility, though they need a little revision One might, for example, be led into error by the statement that iodine is insoluble in water or by the representation of oxalic acid as if its crystals were anhydrous. There does not seem any valid reason for calling ammonium, potassium, and sodium salts as ammonium, "potass," and soda salts respectively, and when uniformity means simplicity and offers no disadvantages, it is always desirable. The editor as usual contributes a long article, this year on "The Plain Facts of Lenses," which is eminently practical and easily understandable even by non-technical photographers. There is also a second article by Mr. T. L. J. Bentley on how to get the best results with the very small cameras that are now in vogue. It appears that 3¼ in. × 2¼ in. is by far the most popular size as compared with either larger or smaller sizes of spools of roll-film.

Life and Science. By Prof. David Fraser Harris. Pp. 204. (London: Andrew Melrose, Ltd., 1923.) 7s. 6d. net.

THE author, in this little work, describes in simple terms the scientific aspect of certain vital phenomena. Written in pleasant style, it appears suitable for the layman of an inquiring turn of mind, who wishes to know something of vital mechanisms without the need of a knowledge of physiology. The work opens with a chapter on the thesis that there is nothing new under the sun, and shows how man's inventions have been anticipated in the mechanisms found in his own body. After a chapter on mechanisms of defence, the author describes certain tissues which are characterised by possessing a rhythmic activity, thus leading up to a discussion of sleep, which is termed "life's great rhythm". stress is laid on the presence of fatigue products in the blood, a lessened blood supply to the brain, and a diminution in the number of sensory impressions reaching that organ In the following chapter examples of "latent life," taken from both the vegetable and animal kingdoms, are described in the next, the rather uncommon subject of "coloured thinking" is dealt with; in these persons certain words or sounds are associated with certain colours, especially when a concept has to be visualised. the condition occurs in perfectly normal people and has no relation to visual hallucinations. The book closes with a plea for a greater recognition of the mutual influence of the mind and body upon each other, illustrated by the subject of faith-healing.

Sunshine and Open Air. their Influence on Health, with special reference to the Alpine Climate By Leonard Hill Pp. vii + 132 + 8 plates (London E. Arnold and Co, 1924) 10s. 6d. net

PROF. LEONARD HILL has brought together in small compass a mass of valuable material bearing on the health-giving properties of sunshine and open air. He analyses the scientific facts which explain the curative effects of the Alpine climate, contrasting the composition and physiological effects of high and low atmospheres. The value of this section is enhanced by a large series of comparative observations, not only on the hours of bright sunshine in numerous stations, but also by the exact measurement of the intensity of the sunlight and that of light reflected from the sky and the ground. These measurements are made both in terms of heat and of their biological action. The chapter on the influence of moisture, mist, temperature is well worthy of careful consideration, as it offers explanations of the morbidity of the town dweller and the risks of infection run in confined sunless communities In the chapter on the biological action of light, the author has summarised a large amount of valuable work done under his supervision in the Department of Applied Physiology in the National Institute for Medical Research. This work comprises the development of instruments for the precise measurement of actinic light both chemically and by its action on protozoa, the depth of penetration of various radiations, and their influence on the blood of animals and man The introductory chapter gives a practical account of the writer's personal experiences of the "sun cure," and the work is illustrated by some very clear half-tone reproductions.

The Chemistry of Crop Production. By Prof T. B. Wood. Second edition. Pp. vii + 193. (London: University Tutorial Press, Ltd., 1924.) 4s. 6d.

THE first edition of Prof. T. B. Wood's admirable little book on the scientific principles of crop production was reviewed in NATURE for March 24, 1921 (vol. 107, p. 101). We are glad to note that a second edition has been called for, and that the publishers have found it possible to reduce the price from 5s. 6d. to 4s. 6d. The text is unchanged, save that the examples are now based on prices current in 1924.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Solar Eclipse of January 24 and Wireless Signals.

DURING the solar eclipse of Saturday, January 24, the engineers of the Post Office and of the International Western Electric Company, at the instance of Admiral Sir Henry Jackson, measured the strength of wireless signals received from New York at Chedzoy in Somerset and at New Southgate, London. The results show that the signal strength rose to a sharp maximum and fell to a very sharp minimum during the progress of the eclipse.

At 14.12 G.M.T. totality occurred at New York and more than half of the trans-Atlantic track of the signals was in partial darkness; at this instant the strength of the signals received in England was observed to be about twenty per cent. above normal. At 14.52 first contact was visible in London, and by this time signals had increased to about double the normal strength. A few minutes later the centre of the total phase was in mid-Atlantic about 400 miles to the south of the wave track, and the whole of the track was now in partial darkness. The signal strength rose to a maximum first at Chedzoy and then at New Southgate. During the next half-hour the centre approached the wave track rapidly by moving in a north-easterly direction, and signal strength decreased greatly. At 15 30 the last contact occurred at New York, and at about 15 40 the signals received at both places of observation had fallen in strength to a minimum value less than one-fifth of the normal. At this instant about 300 miles of the western end of the wave track was in full daylight and the centre of the eclipse was crossing the wave track about 500 miles to the west of Ireland. By 15.45 the centre had moved beyond the Faroe Islands, daylight had returned, and at about 16 10 normal signal strength was regained. Throughout the eclipse directional measurements were made by the staff of the Radio Research Board, but no effect on bearings could be detected.

The occurrence of the maximum and minimum signal strengths on this occasion recalls the observations on the eclipse of Wednesday, April 17, 1912 (see NATURE, April 25, 1912, Vol. 89, p. 191). On that occasion, as there was no conveniently placed wireless station at work, the observations were made on "atmospherics" or "strays," which the meteorological conditions indicated were coming from Spain or North-west Africa. These earlier observations and also the new ones seem to be explained by the ionisation of the atmosphere by sunlight and the re-combination of the ions when the light is removed. This explanation was set forth in a paper read to the British Association in September 1912, as follows:—"My observations indicated that, firstly, when the penumbra stole over Western Europe and Western Africa propagation grew rapidly better; secondly, as the umbra itself crossed the Bay of Biscay towards France it began to hinder propagation, its interference being greatest after it had entered France near Les Sables, which means that at this moment it lay directly between London and the source of the strays; thirdly, that when the umbra passed on, the ionic medley it had created by re-combination of ions faded quickly" and propagation improved. The suggestion here is that the hurried and irregular re-combination of ions produced an ionic turmoil which obstructed electric waves. The obstruction arose, I suggested, not so much from absorption as from irregular refraction, the refraction being a consequence of the dependence of the velocity of electric waves through rarefied air upon the nature and concentration of the ions in it.

The interesting question now arises. What levels of the atmosphere are mainly concerned in these phenomena? Students of wireless telegraphy have long believed that there is an upper region in which free electrons exist more or less permanently and a middle atmosphere in which ions of molecular size are formed daily by sunlight. If I may quote again from my own writings: "Wireless investigators would suggest that the layer beneath the auroral layer is occupied by electrons that have come as beta-rays from the sun. The atmospheric pressure at above 50 kilometres is only about a millionth of an atmosphere, the mean free path of the electrons is therefore long and they may possibly remain permanently free in large numbers. It would seem that the base of this region charged with free electrons must be regarded as the ceiling usually known as the Heaviside layer." At night this ceiling reflects wireless waves of all lengths round the globe as a whispering gallery reflects sound. In the day the air below it is ionised, absorbs the waves in some degree, and gives to the rays a curvature which is greater as wave-length increases. To the Heaviside layer is attributed the "night effect" which afflicts direction finding. As no such effect was observed during the eclipse we may provisionally assume that the Heaviside layer did not come prominently into operation and that the middle heights of the atmosphere were responsible for the phenomena observed.

Sir Arthur Schuster, in his theory of the diurnal magnetic variations (Phil. Trans., A, 208, 1907, p. 182), requires that a portion of the upper atmosphere should possess a conductivity of 10^{-13} electromagnetic units in order to account for the usual variations. Prof. S. Chapman has of recent years elaborated this suggestion. But whether this portion of the atmosphere is above or below the Heaviside layer is not yet clear. It would seem that simultaneous observations of the effects of solar eclipses on the magnetic elements and on the propagation of signalling waves offers a means of solving this question.

W. H. ECCLES.

13 Catherine St., S.W.1,
February 11.

Polarisation of Light from the Sky during the Solar Eclipse of January 24.

DURING the total eclipse on January 24, I was at New Haven, Connecticut, and thus very close to the middle line of the track of totality. For a portion of the period of totality I made a somewhat hasty survey of the state of polarisation of the light scattered by the sky, using for the purpose a Savart plate and Nicol prism. I was only able to cover the eastern sky from the zenith to the horizon stretching from north through east to south, and I was unfortunately not able to determine the plane of polarisation of the light scattered from the various parts of the sky. What I was able to note, however, with certainty was that there was no marked variation in the percentage of polarisation as one explored the eastward half of the sky—that is, there was no trace of the familiar maximum noted when the sun is not in eclipse.

As I am a physicist and not an astronomer I am not sufficiently familiar with the results of observations

of this sort at the time of previous eclipses to draw any conclusions from the fact I happened to note. It may be worth recording, however, as the conditions at the time of the eclipse of January 24 were somewhat unusual in that the entire country surrounding the path of totality was deeply covered with newly fallen snow, and it seems possible that a very large percentage of the diffused sky light may have come by previous scattering from the extensive snow fields on either side of the track of totality, and relatively very little from either the corona or the direct light from the sun on the edge of totality.

AUGUSTUS TROWBRIDGE.

Relativity referred to a Flat Space-Time.

As a preliminary communication, I wish to indicate briefly a few main results which could be made the starting-point of a general theory of relativity which shall fit in, in a natural way, with the Newtonian scheme and older physics and shall avoid the necessity of formulating with Einstein a space-time continuum "curved" by the existence of matter. It would be sufficient, as we shall show, to adopt a space-time continuum which is "flat," for the formulation of physical laws.

Now let us write, in the usual form, the expression for the invariant interval between two contiguous point-events as

$$ds^2 = g_{\mu\nu}dx_\mu dx_\nu, \quad . \quad . \quad . \quad . \quad (1)$$

adopting Eddington's summation convention that whenever a literal suffix appears twice in a term, that term is to be summed for values of the suffixes 1, 2, 3, 4. The $g_{\mu\nu}$, of course, have to satisfy the necessary and sufficient condition for "flat" space-time, namely, the Riemann-Christoffel tensor

$$B^{\epsilon}_{\mu\nu\sigma} = 0. \quad . \quad . \quad . \quad . \quad (2)$$

Having thus defined the geometry we shall use, we shall show now how a consistent formulation is possible of the laws of mechanics, of gravitation, and of electro-magnetism, so as to conform to the general principle of relativity, still adhering to the fundamental concepts of "inertia" and of "force" and the invariability of mass, of the dynamics of Galileo and Newton.

Let us define the mechanical force acting on a mass-particle, by the tensor F^μ, as

$$mc^2\left\{\frac{d^2x_\mu}{ds^2} + \{\alpha\beta, \mu\}\frac{dx_\alpha}{ds}\frac{dx_\beta}{ds}\right\} = F^\mu, \quad . \quad . \quad (3)$$

where m is the mass of the particle, which is considered invariant, and c the velocity of light. This tensor, together with its associated tensors, shall form the mechanical-force tensor.

Now, on equating this tensor to zero, it easily follows that a mass-particle under no forces will describe a straight line in the space-time continuum; this, of course, corresponds to Newton's first law of motion, the law of inertia.

Then, turning to gravitation, we shall have to define the mechanical force due to gravitation acting on a particle. For this purpose let us define an invariant gravitation potential ϕ by the following tensor equation:

$$g^{\mu\nu}\left(\frac{\partial^2\phi}{\partial x_\mu \partial x_\nu} - \{\mu\nu, \alpha\}\frac{\partial\phi}{\partial x_\alpha}\right) = \rho_0, \quad . \quad . \quad (4)$$

where ρ_0 is the proper-density of mass which can be expressed by the equation

$$\rho_0 = \rho\frac{ds}{dt}, \quad . \quad . \quad . \quad . \quad (5)$$

where ρ is the usual density.

Then the mechanical force due to gravitation may be defined by the tensor G^μ as

$$-m\left\{g^{\mu\alpha}\frac{\partial\phi}{\partial x_\alpha} - \frac{d\phi}{ds}\frac{dx_\mu}{ds}\right\} = G^\mu. \quad . \quad . \quad (6)$$

This tensor, together with its associated tensors, shall constitute the gravitational force tensor.

Now let us see how the equations (3) and (6) reduce, under suitable conditions, to the equations of the Newtonian theory For this purpose we shall equate the expressions in (3) and (6). Then we have

$$mc^2\left\{\frac{d^2x_\mu}{ds^2} + \{\alpha\beta, \mu\}\frac{dx_\alpha}{ds}\frac{dx_\beta}{ds}\right\} = -m\left\{g^{\mu\alpha}\frac{\partial\phi}{\partial x_\alpha} - \frac{d\phi}{ds}\frac{dx_\mu}{ds}\right\}. \quad (7)$$

This, being a tensor equation, will hold for all co-ordinate systems if it holds for any. Therefore let us take the Galilean system for which the line-element is

$$ds^2 = -dx_1^2 - dx_2^2 - dx_3^2 + dx_4^2 \quad . \quad . \quad (8)$$

Now, as the equations of the Newtonian theory hold only for velocities small compared with that of light, we have, if we introduce this restriction, approximately

$$ds = cdt.$$

Then the equation (7) reduces, in the Galilean system, to

$$\left.\begin{aligned} m\frac{d^2x_\mu}{dt^2} &= m\frac{\partial\phi}{\partial x_\mu} + \frac{m}{c^2}\frac{d\phi}{dt}\frac{dx_\mu}{dt} \quad (\mu = 1, 2, 3) \\ \frac{1}{c}\frac{d}{dt}\left(\tfrac{1}{2}mv^2\right) &= -\frac{m}{c}\frac{\partial\phi}{\partial t} + \frac{m}{c}\frac{d\phi}{dt} \quad (\mu = 4) \end{aligned}\right\}, \quad . \quad (9)$$

where v is the velocity of the particle

Thus we see that if we identify ϕ with the Newtonian gravitation potential, the first equation of (9) gives the Newtonian equations of motion and the second equation of (9) leads to the equation of activity in a gravitational field Obviously we can identify ϕ with the Newtonian gravitational potential, for the equation (4) reduces for the Galilean system to the well-known form

$$\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} - \nabla^2\phi = \rho_0 \quad . \quad . \quad . \quad (10)$$

We have thus brought gravitational force under the general principle of relativity by expressing it consistently in the tensor form. The second term of equation (6) is the essentially new feature of this theory, and it is curious to note that while it becomes insignificant in taking the space-components of the gravitational force tensor, it becomes quite significant in taking the time-component. The fact that such a term has naturally to come in can be seen by multiplying both sides of the equation (7) by $g_{\rho\sigma}\frac{dx_\sigma}{ds}$ and contracting the product to an invariant, when both sides become zero. It may also be seen that the choice of a gravitational force tensor seems to be limited as we have at our disposal only ϕ, $g_{\mu\nu}$, and $\frac{dx_\mu}{ds}$, and it does not seem to be possible to construct an alternative tensor degenerating to the Newtonian equations unless it be that G^μ of (6) is multiplied by an invariant differing little from unity. But there is no justification for doing this at present.

There is also a striking resemblance between the second term of G^μ of (6), which we shall call the "velocity" term, and the electromagnetic force tensor E^μ, which can be defined as

$$E^\mu = eg^{\mu\alpha}\frac{dx_\beta}{ds}P_{\alpha\beta}, \quad . \quad . \quad . \quad (11)$$

where e is the invariant electric charge and $P_{\alpha\beta}$ is defined by the equation

$$P_{\alpha\beta} = \frac{\partial k_\alpha}{\partial x_\beta} - \frac{\partial k_\beta}{\partial x_\alpha}, \quad . \quad . \quad . \quad (12)$$

where k_μ is the electromagnetic potential tensor, having for its components the three components of the vector potential and the one scalar potential of the electromagnetic theory. Now it is interesting to note that if we combine the mechanical forces acting on a charged particle due to gravitation and electromagnetic forces into a single expression, and if we take them for the Galilean system, the values for the "velocity" term of equation (6) fit in the diagonal of zeros in the following array for $P_{\alpha\beta}$, leaving the other values of the array unaltered

$$\begin{array}{cccc} P_{\alpha\beta} = 0 & -\gamma & \beta & -X \\ \gamma & 0 & -\alpha & -Y \\ -\beta & \alpha & 0 & -Z \\ X & Y & Z & 0. \end{array}$$

Thus we have shown that if we adopt the scheme of equations given above, we can return to the mechanics of Galileo and Newton, with the suggested alteration in the law of gravitation, still holding fast to the ideas of inertia and force and the invariance of mass, without being obliged to make mass dependent on velocity and to obliterate the difference between mass and energy as the special and general theories of relativity would lead us to believe, of course, the variable inertia of electrons at high speeds could well be seen to follow from equations (3) and (11), leaving the notion of the invariability of mass intact

C. K VENKATA ROW.

"Masthu Baug,"
St George's Cathedral Road,
Cathedral P O, Madras,
January 1.

The Biology of the Suez Canal.

THE Cambridge expedition, financed by the Royal Society, which left England in September last to study the migrations of marine organisms through the Suez Canal (see NATURE, vol 114, pp. 520, 866) has returned on the Orient liner *Ormuz* The members of the expedition were Messrs H M Fox, R Gurney, V. C. Robinson, and D N Twist The full results will naturally not be known until the collections have been worked out, but certain general conclusions can already be drawn

Since the communication to NATURE of December 13 last, the central and northern portions of the Canal have been studied Lake Timsah in the middle region of the Canal near Ismailia is characterised by great variation in salinity, unlike the Great Bitter Lake farther south where a high salinity is constant In the centre of Timsah, with a south wind and a current to the north, a density as high as that of the Great Bitter Lake is recorded In other circumstances the density in the same situation is much lower At the edges of Timsah, and in the lagoons communicating with it, all intermediate degrees of brackish water to pure fresh are found The fauna in various portions of the lake is consequently diverse, and in the situations where rapid salinity changes occur must be resistant to these.

It is remarkable that whole large groups of animals, such as anthozoans, echinoderms, brachyuran crustaceans, ascidians, etc, which were absent from the Canal in 1882, are now abundantly represented. Yet the Canal was opened in 1869, and certain forms such as barnacles and cockles established themselves in the region of Lake Timsah from the very commencement. Why then did these other groups migrate in so late? In Lake Timsah the contrary phenomenon is found in the case of Mytilus and Pholas, previously very common, now absent. An attempt is being made to correlate these arrivals and departures with changes in the Canal at different dates. The late immigration of the crab *Neptunus pelagicus*, for example, which started from Suez in 1893 and reached Port Said in 1898 (NATURE, vol. 113, p 714), coincides with the first widening and deepening of the Canal. Again, when the water samples brought back by the expedition had been analysed and compared with past data, the proportions of the dissolved substances in the waters of the Bitter Lake may be found to have altered at a certain period owing to the upper layers of the bed of salt which forms the bottom of the lake becoming dissolved. Such a change could affect migrations But it must be remembered that in general very little is known about the causes of the migrations of littoral marine animals On a sand flat opposite Port Taufiq, Suez, for example, the writer observed large numbers of Synapta in 1920. At the same season in 1921 the ground was covered in addition by quantities of immature Centrechinus. In 1924 both were absent, although the conditions were apparently unaltered

Between the Bitter Lakes and the Gulf of Suez the currents in the Canal are tidal, reversing their direction twice daily, and they are rapid Between the Great Bitter Lake and Port Said the currents are slow and seasonal, flowing to the north for ten months, to the south for two only, namely, August and September The consequence is that the salter water from the Great Bitter Lake extends north to within 40 km. of Port Said (the total length of the Canal is 160 km, and the distance from the Bitter Lake to Port Said 98 km) during ten months, while the less dense water of the Mediterranean penetrates south beyond Lake Timsah (to a distance of 90 km from Port Said) during two months only. The results of this are, first, that for most of the year there is a barrier to the penetration from the Mediterranean of forms which cannot support very salt water, and second, that the salter environment of the Bitter Lake extends far to the north for most of the year with the following possible consequence The fauna of the Bitter Lakes was found to be richer than that of the seas at the mouths of the Canal, but from a study of the Lakes alone it was uncertain whether the favourable factor is a more suitable bottom or the higher salinity. Now between the Great Bitter Lake and Port Said there is a rich fauna on the piers just as far north as the salter water extends during ten months, while between this point and Port Said the pier fauna is noticeably poorer. The substratum is the same throughout, but the salt-content of the water different.

The final field work consisted in an examination of the fauna and flora of Port Said harbour. Further, the bottoms of tugs and barges which had been employed at one end of the Canal were scraped as soon as they moved to the other end, and again after they had been there some time, in order to see what forms could remain alive in their new environment and possibly could have established themselves there in the past, brought through the Canal on the ships' bottoms.

An important side of the work is necessarily incomplete because a part of the Canal fauna is seasonal in its appearance or in its breeding. Large Aurelia-like medusæ, for example, are so common in August that they foul the screws of motor boats, yet they were not found by us. Many animals breed at a different period of the year, so that we will be unable to give a general answer to the important question

of whether this or that form breeds in its new environment or merely migrates in from the sea during the lifetime of the individual. These matters should be further studied by a future expedition working in the spring instead of the autumn

In conclusion, we would like once more to thank the Canal Company for their great generosity in providing lodging and boats and for the unfailing help and kindness of their employés. At the same time we must repeat our thanks to the Egyptian Government, in particular to the Coastguards service, for their very willing assistance H. MUNRO FOX

Zoological Laboratory, Cambridge,
February 6.

Short-period Variations of the Wind.

IF one examines the autographic records of wind velocity and direction obtained at any inland observatory on a summer's day, it will be found that both traces are markedly different during the day-time as compared with the night An occasion on which this effect was very well developed is represented in the traces obtained at Porton on July 5-6, 1923 The anemometer vane is mounted at a height of 13·5 metres and has an excellent exposure. The direction chart shows that during the day-time the wind is characterised by very large variations in direction These variations are, moreover, of a peculiar type It is observed that the wind assumes a fairly steady and definite direction for an interval of the order of ten minutes. It then suddenly swings through an angle of perhaps 60° or even 90° After maintaining this new direction for some minutes, the wind shifts again with equal suddenness Regarded as short-period variations, these shifts are quite irregular in occurrence, although when considered over a period of some hours, the mean direction agrees with that demanded by the pressure gradient In contrast with this behaviour we may compare the trace obtained during the night This is the normal type of trace in which deviations from the mean direction are both small in amplitude and of short duration. The wind velocity record also shows a characteristic effect during the day-time short intervals of nearly dead calm alternate discontinuously with intervals during which the velocity is nearly constant with a value of two or three metres per second It may be noted that the durations of these lulls and gusts are about the same as those of the changes in wind direction. At night-time the velocity trace becomes normal like the direction trace.

The effects described above are much more marked in summer than in winter; they occur during the day and not during the night; and the stronger the sunshine the more pronounced the effect. Moreover, an examination of the Shoeburyness records shows that the phenomenon is strongly developed in off-shore winds, but only very slightly in off-sea winds.

Attempts to explain this phenomenon in terms of the interchange of masses of air at different heights appear to be unsatisfactory for the following reasons. In the first place, observations at Porton tend to show that lulls of this type extend from the ground up to a height of at least 15 metres, and it is difficult to understand how a thin layer of air lying on the ground can be extended to this height. In the second place the experimental evidence seems to indicate the non-existence of descending currents which would be adequate to cause the gusts. In this connexion Mr. C. E. Britton has kindly examined the pilot-balloon observations made at Shoeburyness, and he finds that, under conditions of strong convection, descending currents are conspicuous by their absence. (The vicinity of cumulus clouds is, of course, not being considered.) Thus in all probability the cool descending currents are comparatively slow and are spread over wide areas In this event they will not retain their initial high velocity in the manner necessary to produce the observed gusts.

As an alternative to this explanation, it occurred to Mr. O. F T. Roberts and the writer independently that the phenomenon might be caused by small travelling zones of reduced pressure. Such areas of reduced pressure are presumably to be found at the base of columns of ascending air on days of strong convection. The inflow of the surrounding air towards such centres will necessarily constitute miniature cyclones These miniature cyclones will travel with the general air movement, and their passage will produce, on the present view, the particular type of gustiness which we are here considering. Thus, if one of them passes an anemometer so that its own circulation assists the general air movement, then a gust will be produced, and similarly if its circulation opposes the general air flow, then a lull will result It will also be seen that the passage of miniature systems of this type will give rise to the particular kind of direction variation which is associated with this form of velocity gustiness

Considering the duration of this type of gust in conjunction with the wind velocity, it appears that a common value for the " diameter " of these miniature cyclones is of the order of a kilometre By the aid of Ferrel's equation, it is possible to calculate the reduction of pressure necessary in one of these systems to produce a gust of 2 metres per second in an otherwise still air In this case the cyclostrophic term is far more important than the geostrophic term, and it is found that a pressure difference of about one-twentieth of a millibar is required. Conditions corresponding approximately to this case occurred between 1100 h and 1300 h on the date already referred to The microbarograph trace for the same period shows quasi-periodic variations of about one-twentieth of a millibar, and of roughly the same " frequency " (about 8 to 10 per hour) as the gusts Similar results are found on other days of strong sunshine and light winds

It is interesting to observe that, since the geostrophic effect is so small in pressure systems of this size, the direction of circulation within them will not necessarily always be that of full-sized cyclones in the same hemisphere The direction of rotation will rather be determined by the initial velocity of some part of the air which goes to form the new miniature cyclone. For this reason gusts and lulls will sometimes be accompanied by temporary veerings in the wind direction and at other times by backings

Interpreted in terms of eddy-diffusion, the effect described above may be regarded as implying a very large value for the horizontal components of the coefficient of eddy-diffusion if considered over a long time interval. But if considered over a period of say half an hour, then the effect can only be regarded as irregular. The special characters assumed by the wind velocity and direction in these circumstances may also be regarded as special types of variation in the longitudinal and lateral components of the wind It is a matter of some interest to ascertain whether, under the same conditions, the vertical component of the wind acquires any corresponding peculiarity. Although it has been shown by Taylor (Advisory Committee for Aeronautics, Reports and Memoranda, No. 345) that in general the longitudinal, lateral, and vertical components of gustiness are

approximately equal, it was thought worth while to construct an instrument which will provide continuous records of the vertical component of the gustiness of the wind. Such an instrument is now in operation at Porton, and it is hoped that it will throw further light upon the nature of the short-period variations of the wind near the earth's surface.

N. K. JOHNSON.

Meteorological Department,
Experimental Station,
Porton, Wilts.

Estimating the Qualities of a Photographic Plate.

THE testing of photographic plates presents to-day a number of complexities, and is so wholly unsatisfactory from a technical point of view that two special meetings have been convened by the Royal Photographic Society, held on January 7 and February 10, at which discussions have been held, and suggestions made, by leading authorities for a better system of estimating the speed and general characteristics of sensitive emulsions A special committee has also been appointed to consider the suggestions resulting from these discussions, which are to be forwarded to an international gathering in Paris next June, where it is hoped that some new system may be generally agreed upon

The accepted method of plate-testing, devised by Hurter and Driffield in 1890, is to expose sections of a plate to a standard light source for times increasing geometrically, and after development under standard conditions to measure the densities of these strips and to plot them as ordinates against log exposure The result is a curve of the well-known form shown in Fig. 1, *PQRS*. But with the very great increase in speed of modern plates these "characteristic curves" often show a type of curve like *XYZ* in Fig. 1.

In curve *PQRS*, *PQ* is termed the under-exposure

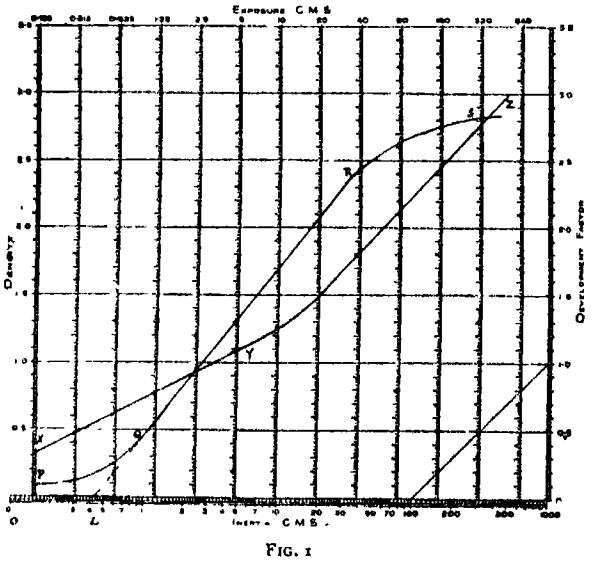


FIG. 1

portion, *QR* the straight-line portion, representing the "period of correct exposure," and *RS* the over-exposure portion. With many high-speed plates *PQ* stretches out to *XY*, *i.e.* the under-exposure portion becomes straight, and indeed most studio negatives as made by the professional photographer of to-day utilise only this part of the curve; on higher exposures the curve may jump upwards, as shown by *YZ*, such a plate giving good density in the extreme "high-lights," but soft, uniform gradation in the half-tones and "shadows."

If the straight-line portion of curve *PQRS* be produced to cut the log exposure axis at *L*, *OL* represents the inertia of the plate, and its reciprocal represents the speed; $34/OL$ gives the accepted H. & D. speed number.

Nietz has, however, shown that if several plates,

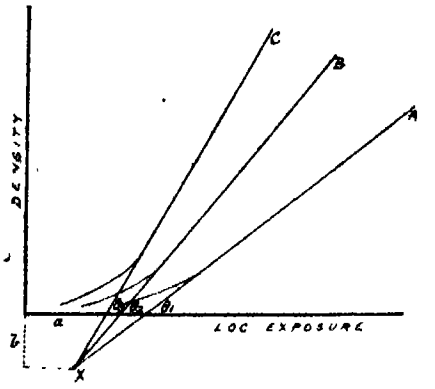


FIG. 2

given the same exposure, be developed for different times, and their curves plotted, such curves, *A*, *B*, and *C* for example in Fig. 2, may intersect at some point *X*, *below* the log *E* axis if there is free bromide present in the silver bromide emulsion, as is almost invariably the case. In such a case the inertia, as seen, will vary according to the time of development, and he suggests using the co-ordinates *a* and *b* in making the speed determination.

The contrast-giving power of the plate is measured by the steepness of the curve, and is called the development factor, γ. This is proportional to tan θ, and clearly γ will be different for different times of development, being $k \tan \theta_1$ for *A*, $k \tan \theta_2$ for *B*, and $k \tan \theta_3$ for *C*.

Here, then, are some of the difficulties with which we have to deal, and on which some general convention is so urgently needed. Take curve *XYZ* in Fig. 1, for example. Shall we extend *ZY* to meet the log *E* axis to give the inertia, or shall we extend *YX*? Shall we plot a family of curves developed for different times, and use the co-ordinates *a* and *b*, where the speed number *H* could be obtained independent of the contrast-giving powers of the plate by using an equation of the form

$$\log H = \log k - a + b\ ?$$

Another difficult problem is to express the under- and over-exposure parts of the curve simply. *PQ* (Fig. 1) is of paramount importance to photo-engravers in the making of half-tone and line reproductions, as on it depend the "woolliness" of the dots and diffuseness of edge of a line. *PQ* and *RS* are of vital importance to the physicist where he is attempting to measure either light intensities or radiations by means of *density*,—the only portion of the curve that may be used is that in which log density/log exposure is absolutely constant; *i.e.* he must use *QR* only.

The wave-length limits of the light source also affect gradation to some extent, and some primary and secondary source of light, universally adopted, is most desirable.

The position may be summed up by saying that, in view of the very extended applications of photography to science and industry, and the extensive

use of half-watt lighting for studios by the portrait photographer, some fuller means must be found for expressing the characteristics of a plate and for interpreting its properties. T. THORNE BAKER

Research Laboratory,
Imperial Dry Plate Co., Ltd.,
Cricklewood, N.W.2.

Excitation of Forbidden Spectral Lines.

HANSEN, Takamine, and Werner (*Kgl Danske Videnskab. Selskab Mathfys. Medd* 3) have observed the line $1S - 2p_1$ (Paschen's notation) of mercury in a condensed discharge, and Takamine and Fukuda (*Phys. Rev* 25, p 23, 1925) have found the line strongly developed in the glow of a branched arc We have excited this line, the corresponding line of zinc, and both $1S - 2p_1$ and $1S - 2p_2$ of cadmium in the positive column of a hot-cathode discharge. The positive column was viewed end-on while the cathode glow was confined to a side tube. The potential difference across the entire tube was of the order of 100 volts, but the tubes employed were of such length, 30 to 100 cm., that the voltage drop per mean free path of an electron was quite small. The spectrum is strictly of the arc type, only a few of the more readily excited spark lines appearing, and these in comparatively low intensity

The cadmium lines, λλ 2230, 2267, 2307 and 2329, were sharply absorbed by the positive glow, a spark under water or discharge in a hydrogen tube being used as the continuous background These lines have been independently classified by both Ruark and Paschen (unpublished) as belonging to the group $2p - 2p^1$. Other members of this group involving transitions from the $2p_1^1$ level were definitely not present in absorption An unknown line at λ3086·7 appeared on some of the exposures as a weak but sharp absorption line

PAUL D FOOTE
T TAKAMINE
R L CHENAULT

Bureau of Standards,
Washington, D.C.

Radio Reception on Frame Aerials.

EXPERIMENTS in the reception of medium-powered distant broadcast stations on small frame-aerials of particularly small high-frequency resistance, with the use of correspondingly light reaction-coupling of the type usually associated with the name of Reinartz, appear to indicate that the commonly-accepted ideas as to the magnitude of the high-frequency voltages which can be registered on such aerials with small total tuning capacities across them, in these circumstances, require some modification.

With a frame of approximately circular form and 1 m. diameter, with 11 turns of thin bronze strip 6 mm. wide, spaced at 8 mm. in the form of a flat spiral (2 extra turns providing the Reinartz reaction-coil); and using a detector-valve and one transformer-coupled audio-frequency amplifying valve, both of amplifying factor M = 20, I was able to observe clearly intelligible speech and music from about thirty British and Continental stations, ranging from Aberdeen to Rome, in the course of one Sunday evening, in a quiet high point 35 miles N. of London, and on the first floor of a substantially-built house. Many of these stations, including the last mentioned, were later audible on a loud-speaker in a very quiet room; corresponding to a R.M.S. audio-signal-voltage of an average order of 0·3 volts. I had previously observed that, with an additional high-ratio transformer-coupled audio-frequency amplifying valve (three valves in all), at least two American broadcast stations could occasionally be heard, subject to the usual fading, on an even smaller aerial

The tuning and reaction-control were of an unusually fine order, and oscillation-hysteresis had to be carefully eliminated The signal-voltages observed here appear to be inconsistent with the usual estimates, and suggest also a revision of current practice in "radio-frequency amplification"

A. D COWPER

An Experiment with a Stroboscope.

ON page 543 of vol III of the "Dictionary of Applied Physics," an experimental arrangement is described where the stroboscope disc is illuminated by an intermittent light, using a neon-tube, an induction coil, and an electromagnetically controlled tuning-fork The same experiment can be performed in the light of an ordinary neon filled 110-volt Osglim lamp to which current is supplied from an alternating-current lighting circuit If the laboratory supply is of continuous current, then the arrangement can be considerably improved with the use of a rotary convertor the speed of which can be regulated so that the frequency of the intermittent light can be ascertained directly with a speedometer and stop-watch. As a demonstration experiment this arrangement is particularly convenient, since both the stroboscopic disc and the frequency of the source of light can be varied at will, and very interesting effects may be observed G R PARANJPÉ

Royal Institute of Science,
Bombay,
January 2

The Crisp Collection of Microscopes.

MAY I add a note to the brief statement referring to the Crisp collection of microscopes in NATURE of February 14, p 241? Doubtless it is true that on occasion the late Sir Frank Crisp may have led the authorities to believe that he contemplated leaving his collection to the Science Museum at South Kensington, but it is equally true that his chief desire was to see his collection used for the preparation of a comprehensive history of the microscope in amplification of Mayall's Cantor Lectures, printed in 1886 Some years ago he asked me whether I would be willing to compile such a history, and he gave me a few notes on his instruments for the purpose Last week I received a letter from my friend Prof Poulton, in which he recalled a conversation with Sir Frank Crisp. "I remember his telling me that he did not know what to do with it (the collection), and I tried to persuade him to leave it to the Pitt Rivers Museum. If the collections now in the Old Ashmolean had been there, then I expect he would have left it to Oxford" This I believe to be the truth Sir Frank Crisp did not desire to duplicate the series in the possession of the Royal Microscopical Society, or that his collection should be merged in a larger one, and only be partly exhibited. But the facts that many of the parts of the instruments have got mixed, that historic examples have been divorced from their history, that the collection has been distributed without having been properly catalogued, is an international calamity.

R. T GUNTHER.

Magdalen College,
Oxford,
February 14.

The Investigation of the Properties of Thin Films by Means of X-rays.[1]

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

THERE are a number of problems of the highest importance which are, or can be, contained in the study of what we often call the "thin film." They are linked together by the fact that most reactions between bodies are largely determined by what takes place at their points of contact, and therefore by the nature of their surfaces. What is to be found in the interior of the body is often of much less importance than the composition and state of its surface film. The immensely varied problems of surface tension are examples of one kind; the phenomena of catalysis, of friction and lubrication are examples of other kinds.

Though the thickness of the surface film is so important, it is often very small—beyond the limits of direct optical measurement. The X-rays measure more minute quantities than the microscope, and we may well ask if they can carry us any further. They measure only, it is true, the spacing of a stratification, and a stratification cannot consist of a single layer or film: so that the rays cannot be applied directly to the examination, for example, of the black spot on a soap film. But they are able to help in an indirect yet effective way. For they deal with problems of the arrangement of molecules, and all these manifestations of surface action are directly dependent on the arrangement of the surface atoms and molecules. Also the substances, the actions of which in single thin films are of great interest, are often found multiplied into crystals which actually can be examined by the X-rays.

The soap bubble and soap film have long been studied for their beauty and their interest. Since they have so large a surface in comparison with their volume content, they offer special advantages for the examination of surface actions. Yet they are so full of detail that even with the last few years new and most interesting discoveries have been made with respect to them. It will be convenient to review some of these briefly as illustrations of the facts that have to be accounted for.

When the bubble is near its end a black patch often appears, and soon afterwards the bubble bursts. The patch is black because it is so thin, and therefore reflects little light. It might be thought that the "black spot" represents a breakdown in the structure, a forerunner of collapse. But it is in reality a relatively stable affair: in proper circumstances it can be maintained for hours and days, as Sir James Dewar loved to show. Reinold and Rucker, Rayleigh, Johannot, and many others were greatly interested in the sharpness of its outline, its thinness, and the uniformity of its texture. They recognised two degrees of blackness, as Newton had done long before; they supposed them to represent a single film and its duplication. They succeeded in measuring the thickness, and estimated it to be about 60 Angstrom units in the case of the thinner and twice as much in that of the thicker.

When a film is correctly prepared and mounted, the black spot appears at once at the top of the film, a horizontal line separating it sharply from the rest with its horizontal bands of colour. Small black spots are continually forming at various points of the coloured film and rushing up to join the main spot: it is, of course, the downward movement of their surroundings which makes them move in the opposite direction. Sometimes minute points of light like stars appear, moving about on the surface and especially at the edges of the black spots—drops of water apparently.

When observations of this kind are made in the quiet of a laboratory, with small and more manageable films and with special instrumental facilities, a fineness of detail is revealed which cannot be followed on the screen. Our knowledge of these details is due to the beautiful work of Perrin, published in 1918, and to its repetition by Wells in 1920. To state Perrin's results very briefly, it appears that the two degrees of thickness first observed are due to the existence of a very thin uniform film and its doubling, as had already been shown, that the existence of three more degrees of blackness observed by Johannot was due to further repetitions of the same layer, and that a close examination revealed the existence of dozens of these layers, all multiples of the same fundamental thickness. In the blackest spot there was but one layer, and this was, strangely enough, the most stable of all. Other similar layers could be found superadded, like sheets of paper of the same uniform thickness, until the film was thick enough to show the rich colours of Newton's rings which the soap film ordinarily displays. As we know, the colour of the film is an indication of its thickness. For example, the colours proceed from black through greys, becoming lighter and lighter as the thickness increases, then to a nearly pure white, then through straw-yellow, yellow, orange-red, dark red to a violet, which always changes very quickly with alteration of thickness, and so forms a definite stage. The thickness has now reached (for water) about 2100 Å.U. Perrin counted 37 to 38 steps by which the superimposed sheets mounted to the full thickness that gave the violet tint. He made measurements also with monochromatic light and as his final result arrived at the conclusion that the thickness of the single film was about 52 Å.U. Wells found a somewhat smaller value, namely, 42 Å.U. Perrin, and Wells after him, concluded, on evidence which we have not time to consider, that the single film was composed of a double layer of oleic acid, arising from the hydrolysis of the sodium or potassium oleate in solution.

Now Rayleigh, Devaux, and more lately Langmuir, Hardy, and Adam have measured the thickness of an oil film spread on the surface of water. It appears that in the case of a fatty acid such as stearic or palmitic, when the surface is fully charged, the long chains stand on end, their carboxyl terminals rooted in the water, for which they have a great attraction, and their methyl terminals are turned outwards. The length of the oleic acid molecule is about 23 Å.U. It is clear that this length can easily be in agreement with the suggestion made by Perrin. His film of 52 Å.U., or 42 Å.U. according to Wells, would consist of two layers of oleic acid molecules, the carboxyl ends meeting in the centre. The molecules are held together, side by side, to form a strong sheet, while the methyl groups form a surface reacting very slightly with anything outside.

[1] Discourse delivered at the Royal Institution on Friday, January 16.

The examination of crystal forms by means of X-rays shows that the peculiar arrangement of the molecules in these films on water extends also to the solid crystal in a great number of cases, and may probably be considered as characteristic of the structure of a large and important class of substances It is in the first place to be found in the solid forms of the fatty acids, hydrocarbons, alcohols, and other long-chain molecules These have been examined by Piper at Bristol, and by Muller and Shearer in the Davy Faraday Laboratory I referred to a few of these a year ago The number examined has been largely increased during the last twelve months, and the results that have been obtained are ready for publication

When a small quantity of one of these substances is placed upon a plate of glass or mica, either by melting or by pressing, a formation of layers results, much more so by the latter operation, for it would appear that the pressing and working encourage the arrangement of the molecules and the regularity of the layers that are formed The material is now placed on an X-ray spectrometer, and a photograph is taken by the method of the revolving crystal The photographic plate shows usually a number of lines which clearly represent the orders obtained by reflection from the plane of the layers. In this way the thickness of the layer can easily be measured with an accuracy of about 1 per cent Ten or more orders are often observed. The cleavage plane of many crystals, especially of the class I am describing, often gives several orders, but not usually so many as in this case. other reflecting planes may give only one, perhaps two, higher orders of moderate strength, more often only very weak reflections, except in the first order. No doubt the case is parallel to the well-known effect in optics, where a grating yields many orders of spectra when the lines are sharp and fine. The "line" in this case is a well-defined discontinuity in the distribution of scattering centres which occurs at the ends of the long molecules, a defect would be caused by the presence of the hydrogens of a methyl group, an excess by the oxygens of a carboxyl group. We may suppose the planes which separate layers of these molecules to be well marked in this way, and that otherwise there is a fairly even distribution along the body of the molecule.

If we plot the spacing of each substance of any one series against the number of carbon atoms in the chain, we find at once that the indicating points lie exactly on a straight line, except when the chain is short. This has been proved by Muller and Shearer for the fatty acids, hydrocarbons, alcohols, ketones, and in other cases, and the regularity of the results leaves no doubt as to facts. The increase for each carbon atom is either about 1·0 Å.U. or 1·3 Å.U, the former occurring in the fatty acids, for example, and the latter in their esters.

If we may assume that the molecules lie perpendicularly to the layer, the numbers found for the thicknesses are actually the lengths of the molecules, and there is some ground for supposing this to be often true. But, of course, the molecules might *not* be normal to the layer, in which case the length of the molecule would be more than the thickness of the layer. It is certain that this may sometimes be so. Small crystals of substances of this class have been obtained and successfully measured in these laboratories by R E. Gibbs, in spite of the fact that they each weighed only about a hundredth of a milligram. Gibbs finds that the crystals are of monoclinic prismatic form

In this instance, then, the molecule is not upright but sloping. It is difficult to imagine that the molecules all slope one way in the oil films on water, there would surely be some unique and recognisable direction in the film. It is possible that the explanation may be found in the fact that there are actually two ways, perhaps several ways, in which the molecules arrange themselves Gibbs has found an orthorhombic as well as a monoclinic form, and Muller has observed that a hydrocarbon gives a somewhat different value for the spacing when it is only a few degrees below its melting-point The physical appearance is different in the two cases. In the latter the film is translucent in the usual case it is opaque, probably on account of minute crevasses formed during shrinking This may be the cause of the change we see passing over cooling candle grease: it is transparent one moment, and suddenly clouds over

The inclination of the molecule to the plane of cleavage must be finally settled before we are quite sure that we are measuring the actual lengths of the molecules, but we may hope for an early solution.

The fatty acid molecules are in double layers, but the hydrocarbons are not We know this in two ways In the first place, the actual increase in length for each carbon atom is twice as great in one case as in the other. In the second place, the even orders of the fatty acid spectra are very weak compared to the odd orders

Such an effect can be produced in an optical grating by an alternation of white and black lines on a grey ground. An alternation of strong and weak black lines gives strength to the even orders substituting white for one of the blacks is equivalent to changing the sign of its contribution Gratings can be so made as to illustrate the point If molecules pointing opposite ways are joined by their carboxyl terminations, then the methyl ends of the molecules are weaker in scattering centres than the general average along the molecule, but the parts where the carboxyl groups join together are above the average in strength

Shearer finds another illustration of this effect in the case of hydrocarbons which form a single layer, but are converted into ketones by the substitution of oxygen for hydrogen at some point of the length When the substitution is at the middle of the chain, there is at that point an excessive number of scattering centres, and we have again the circumstances that cause reinforcement of the odd orders. But if the substitution is not at the middle of the chain, the odd orders are no longer strong compared to the even.

We have, therefore, in these stratified layers which we are examining by the X-rays, the very same formation that Perrin has observed in the liquid films. The molecules are found, without exception, to be extended to their full length, and linked together by their carboxyl terminals. Shearer finds the length of the double molecule of oleic acid to be about 36, which is to be compared with the 52 of Perrin and the 42 of Wells.

The conditions which lead to the formation of films on a water surface, and layers in the fatty acids and similar bodies, are operative also in the case of a large

number of more solid crystals. A certain flakiness is the result, the crystals cleaving very easily into thin layers which slide readily on one another, and often give a greasy feeling to the crystal.

Naphthalene and anthracene are cases in point. Their molecules are long and narrow, and are arranged side by side like the oleic acid molecules on water. A single layer is like the corn in a field; but they lean over like the corn when a wind is blowing. They are not perpendicular to the layer. The bonds that tie the molecules side to side must be stronger than those that tie them end to end, because the flakes are so easily parted from one another. The naphthalene molecule contains two hexagonal rings of carbon atoms and the anthracene molecule is extended by the addition of a third, so that the layer is thicker in the latter case In both cases the molecule has a centre of symmetry, and in each layer the molecules are divided into two classes in respect to their orientation. Any member of one class is joined up by ties of some sort to several (probably four) members of the other class, which immediately surround it in the flake; and it would seem that this cross linking holds the flake together and gives it its strength

It is likely that a very large number of other substances are built on the same plan Even when their examination has not yet been attempted by means of X-rays, their crystallographic measurements suggest the fact.

In other substances a similar external form is attained by a somewhat more complicated internal arrangement. The molecule has of itself no centre of symmetry, in fact no symmetry at all, and twice as many are required in the construction of the monoclinic prismatic unit of pattern. This is the case, for example, with benzoic acid, and probably with many of its derivatives But there is the same flakiness which may be put down to the same causes: (1) the general orientation of the molecules so as to lie across the flake, and (2) the hydrogen terminations In all these cases we find that the crystal is tied together by links extended from each molecule to neighbours of the other possible orientations: this seems to be an essential feature of crystal construction. It cannot, of course, be followed in the lowest type of crystalline symmetry, where there is but one orientation possible, and every molecule is arranged exactly as every other. But though this arrangement can be conceived, it is doubtful whether there is a known case it has been shown by Astbury that calcium thiosulphate, generally quoted as the solitary example, has probably the symmetry of Class 2, which contains two orientations, connected by a centre of symmetry Whether this is so or not, it is certain that in at least the vast majority of cases, cross linking is an important feature It may very likely be a factor in the determination of the faces that appear on a crystal A face will naturally contain specimens of more than one molecular orientation, so that the elements of the face may be tied together strongly. For example, in naphthalene, as in many other cases, all the usual faces contain equal numbers of molecules of the two orientations. one might even predict the arrangement from the knowledge of the form.

If, therefore, we survey the general characteristics of this large class of flaky crystals, we observe that the monomolecular films of Langmuir and the multiple stratifications of Perrin, and the whole range of "thin films," have much in common with the solid members of the class. Yet there are significant differences. It seems possible by studying both resemblances and differences to obtain some fresh light on the properties of the more "liquid" films.

With these facts before us we may perhaps formulate a more detailed theory of the black spot on the soap film. The ordinary thick film is bounded on each side by the monomolecular film of oleic acid. In this film there is certainly arrangement. Adam, in particular, has examined the compression of the film under applied forces, and his observations and conclusions fall in naturally with the ordered array that we should expect to be there. But the film is imperfectly crystalline. It is compressible up to a certain point, and during the range of compression may be considered as a two-dimensional gas. The perfect crystal of this class of substance is found in the films studied by Muller and Shearer, and in the minute crystal which Gibbs has measured. The perfect crystal of oleic acid contains twice as many orientations as the film of oleic acid on water: the molecules on the water are only one way up, and the reversed molecules are required to complete the structure.

Suppose, however, that the oleic acid films on the two sides come into contact anywhere; the conditions for the completion of the crystalline structure are now all present. The carboxyl groups not only meet, but interlace: each molecule in the upper group linking together two or four molecules in the lower, and vice versa. This is doubtless a far more stable form of arrangement than that of the single film. The two outside single films, once united in one place, must increase their area of contact, and will drive the expelled water before them until the accumulating heap becomes too great for them to push any further, the action being assisted by the tension of the rest of the film

The film thus formed is a real crystal, because it contains all the molecular orientations. The black spot is simply the thinnest possible flake of oleic acid. It is true that oleic acid melts at 11° C., but the crystalline structure is there, in a mobile state. Solution cannot be made to enter between the two surfaces now united in crystalline fashion. Other films may be formed and float about on it, holding on by virtue of the feeble attractions of the methyl groups on one another: even the pressure of the air must help in keeping them together. These added films will slide about easily; they also will be true crystals of oleic acid, probably without any water.

The differences between the conditions and structure of the black spot on one hand and the neighbouring thick film on the other are so great that we may cease to wonder at the sharpness of the boundary and the enormous change in thickness: on one side of the boundary the thickness may be hundreds of times as great as on the other.

When the black spots appear and rise through the thick part of the film to join the general black area at the top, they leave trails behind them: they look like tadpoles swimming up to the top of the water. When the motion becomes less violent the tails shrink into small circular spots. On the other hand, if a thick

patch is forced by the general turmoil into the middle of a black film, it tends also to a circular shape.

We come now to another of the important surface effects, namely, that of friction, or, stated inversely, of slipperiness These flaky substances are in general slippery and greasy to the touch. The greasy feeling seems to be due to the ease with which the flakes are split from the main body of the substance, and then slide over it. Graphite is an extreme example of the flaky state: and without forcing its inclusion in the class of substances we are considering, we observe that the atoms in each flake are tightly tied together, and that there is a very weak linkage between a flake and its neighbours It is the combination of these conditions that makes for good lubricating qualities. Now in these substances the same conditions hold to a greater or less extent: the molecules of stearic acid, for example, are tied together more tightly side to side than across the ends at which the methyl groups are attached. If, therefore, stratification exists to any considerable degree, the same consequences follow as in the case of graphite. In general, stratification is incomplete, which is another way of saying that a large perfect crystal of stearic acid is never seen. Pressure is one agent that causes stratification, so that if one presses a piece of stearic acid or other material, the very pressure produces the conditions for easy slipping. I have already mentioned that Shearer and Muller have often found that a portion of the material melted on to a piece of mica or glass, and placed on the spectrometer in the necessary position for giving reflections from planes parallel to the glass, was comparatively ineffective in this respect. It would give clear evidence of those two spacings which are found on all the plates, and are ascribed to the widths of the molecules and are independent of their lengths. When the specimen was pressed, or rubbed down on to the plate, the stratification spacing appeared at once, and the others disappeared, thus showing the nature of the rearrangement that had taken place. It may be that this effect explains other properties of greases. I am told that the special grease used in binocular fittings is made serviceable by working with a palette knife

We must recognise, however, that the layers built into the crystal are not at all times ready to slide, otherwise a mere tilt of the crystal would cause them all to slide off one another like a pack of cards. There is a sticking friction to be overcome, exactly as in graphite. It is only possible to speculate as to the cause · perhaps it is a real molecular effect, and sliding only occurs when the bonds, weak as they are, are further weakened, as if the substance was about to melt: perhaps it is rather a mass effect and due to imperfect crystallisation.

It seems not unlikely that, at its best, slipperiness in these cases is almost perfect. Between two perfectly formed methyl layers there is very little friction indeed, perhaps none at all. The methyl layer is seen at its best on the surface of the black spot in the soap film, and various writers have noted that one layer slides very easily over the other. Perrin, in fact, has directed attention to this remarkable effect, as shown in the Brownian movement of fragments of one layer, lying on and sliding over another.

In some of the experiments of Sir William Hardy and Miss Doubleday the condition of nearly complete slipperiness is attained Their beautiful researches on "boundary lubrication," that is to say, the slipperiness of very thin films, have established certain rules of surprising simplicity. They have found cases in which friction nearly vanishes, and in general accordance with the above, they frequently occur when a solid lubricant is practically wiped and rubbed off the surface, a true stratification in a very thin film being probably left.

Not only the phenomena of surface tension and of lubrication, but also those of catalysis, must be intimately connected with the actual arrangement of molecules. We speak of stereochemistry as showing the relations of the atoms in the molecules to one another, their mutual orientation and distances To deal with these subjects we shall have to extend stereochemistry to cover the mutual distances and orientations of molecules as well as of atoms. We see that we must not treat a molecule as if it were simply a sphere attracting according to gravitational laws: it is not even sufficient to speak of an atom in this way, except as an approximation in the case of ionic substances like rock-salt. If some super-Brobdingnagian inquirer were to argue from effects observed on the surface of the earth as to the nature of the human beings to which the effects were ascribed, and being unable to detect a single individual by the most refined methods of which he was capable, should say, "Let us provisionally assume the human being to be a sphere, having similar properties in all directions and no special points of attraction," he would not get very far towards a satisfactory explanation of his subject. It would be an advance should he recognise the existence of two types of opposite sign, and lay the foundations of an ionic theory of heteropolar assemblages, but even then he would fall far short of the truth In the same way, when we try to explain surface tension as the result of the mutual gravitational attraction of spherical atoms or molecules, we cannot make much progress Indeed, we sometimes arrive at consequences that appear startling, as when we determine their attractions by measuring the energy required to tear surface molecules away in the process of evaporation, and then proceed to deduce the existence of pressures of thousands of atmospheres within the body of a liquid. So we may measure the force required to tear away the fringing links of a piece of chain mail, take them to be due to mutual attraction between the links, and thence deduce the existence of an enormous pressure within the piece.

It is when we consider a catalytic surface as possessing active centres on its surface, the relative positions, magnitudes, and mutual distances of which are such that two wandering molecules of different kind, attracted by these points, may be held together in a special way, that we get some idea of the fundamental action of catalysis. It is important to consider, as the basis of surface actions, the arrangements of the molecules at a surface, both arrangements that actually exist, and those that are predisposed to exist This idea runs through all the work of those experimenters, Langmuir, Harkins, Hardy, Adam, Perrin, and many others who have made such progress of recent years: the X-ray studies emphasise this view and supply many quantitative measurements by which it may be shaped and strengthened.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

8. THREE GÖTTINGEN PROFESSORS, AND AN ADVENTURE.

WHEN I went to spend two months at Göttingen in the summer of 1874, Wilhelm Weber (1804–1891) had just retired from the professorship. I doubt whether the present generation of physicists are familiar with his work, though there was a time when electricians talked about weber-currents, galvanic-currents, and faradic-currents as if they were different things. I feel sure, however, that chemists have not forgotten Friedrich Wohler (1800–1882), who occupied the chair of chemistry at the University of Gottingen during forty-six years. Both men were Copley medalists Wilhelm Klinkerfuss (1828–1884) stands on a somewhat lower level of distinction, though he did meritorious work, was amongst the first to recognise the importance of Doppler's principle, and discovered six comets.

When Weber was first appointed to the chair of physics at Gottingen in 1831, that University formed part of the kingdom of Hanover. When its connexion with England was finally severed in 1837 by the accession of Ernest August to the throne of Hanover, the new king repudiated the constitution which the country had enjoyed for a considerable time. Seven professors of Gottingen protested against this autocratic action and had to leave the country They included, besides Wilhelm Weber, his brother, the physiologist, and Jacob Grimm, the writer of fairy tales Weber was offered a chair at Leipzig, where he remained until he was reinstated at Gottingen in 1849. In 1874, at the age of seventy, he was still full of vigour. A short man with a clean-shaven, round, and smiling face, he was ready to discuss the current scientific problems with freedom and sagacity I much enjoyed the two occasions on which he invited me to join him in his walks along the walls of old Gottingen

A man's mentality often finds significant expression in the way in which he shakes hands Kopp, of Heidelberg, used to raise the proffered hand slowly to the level of his short-sighted eyes, and keep it there for a few seconds as if wondering what to do with it. Weber raised his arm vertically upwards and swung it down in a swift and forcible sweep, as if he really meant it. I was told that, under the influence of Zollner, Weber had taken up spiritualism, but I never knew that side of him

In contrast with Weber, Wöhler seemed to live entirely in the past I only spoke to him twice, but while fond of relating old reminiscences, his conversation generally ended in a recital of his personal ailment. I can only remember one of his tales He had an official residence above his laboratory, and one night he was awakened by the noise of an explosion. He gave a graphic description how, with a candle in his hand, he went down to see what had happened. At the point of opening the door—he hesitated. Could there still be some explosive gases hovering round the laboratory? He blew out the candle and entered the room, and found indeed that he had narrowly escaped losing his life by a second explosion. There is not much in this story, but Wöhler seemed to be very proud of this testimony to his presence of mind.

I had called on Wöhler at the express wish of Roscoe, who sent him, through me, a small flask filled with vanadium salt. Wöhler was delighted, and could scarcely believe that this was for him to keep and not only to look at. He had been doing some work on vanadium himself with only a small quantity at his disposal, and on every occasion that I met him he always expressed surprise that Roscoe could spare so much of it. The day following my first call, on returning to my lodgings, I found a visiting card with his name neatly written on it.

Klinkerfuss was a man of different type and calibre. He generally took his meals in common eating-houses surrounded by students, and occasionally I was one of the party He used to entertain us with inferior jokes One example must suffice. "I have always had a remarkable memory for numbers," he said. "At school in the history lesson I could remember every date. Unfortunately, I always forgot what happened on the dates" It was said of him that when he received his salary he spent his money lavishly eating and drinking in the most expensive places, and when he had spent nearly everything he lived mainly on sausages and beer. His duties sat lightly upon him By a general rule of the German universities, a professor is not obliged to lecture to less than three students (*tres faciunt collegium*), and when at the beginning of term one of them called to inscribe himself for the course which had been announced, Klinkerfuss told him that he would have to find two others who also desired to attend. It was said that if half an hour later another man came with the same request, he received the same answer, and it was only when the term was in full swing that the disappointed students became known to each other. I do not vouch for the story. The facts that the fees go to the professors, and the well-known impecuniosity of Klinkerfuss, speak against it. He ultimately ended his life by committing suicide.

There was another professor at Göttingen, a philosopher and theologian, with whom I had some acquaintance When I called on him, he warned me that the life in Göttingen was different from that at Heidelberg. The students were more formal, and inclined to take offence if one did not conform with their codes of behaviour. It was not many hours before I had occasion to regret that I did not attach more importance to his warning The evening of my visit to him I went to some open-air place of entertainment where I met an acquaintance, who was accompanied by three other students. He asked me to join his party, but I told him that I was on my way home. Ultimately, he persuaded me to sit down for a few minutes. While I was talking to him I overheard remarks, made by his companions, about the impertinence of sitting down at a table without a proper introduction. I knew I was in for it, but awaited developments. Suddenly one of the men got up, placed himself right in front of me, clicked his heels together, and said, "My name is von

[1] Continued from p. 234.

Eberstein" (the names are imaginary). I gave him my name in return. After a minute or two the second man got up: "My name is Goldschmidt." I gave him my name. When the third man got up I fortunately remembered that I had a trump card to play, and after he had gone through his ritual I replied, "My name is Dr. Schuster," laying stress on the title. Whereupon all three silently left in a body. My degree was a sufficient distinction in rank to justify me in dispensing with the formality of asking for an introduction to them. I asked my friend what would have happened if I had not been a graduate: his reply was, that I should have had either to fight at least one duel or been treated as an outcast by German universities. All this happened fifty years ago, and must not be considered to apply to the present day.

Obituary.

SIR JAMES MACKENZIE, F.R.S.

BY the death of Sir James Mackenzie the medical profession and the world at large has lost a physician whose life was devoted to the advancement of our knowledge of practical medicine. His researches on diseases of the heart effected nothing less than a revolution in this branch of medicine, which had been stagnant for nearly a century

Sir James Mackenzie was born at Scone in 1853, and received his medical education at the University of Edinburgh, where he graduated in 1878 After extending his training by resident appointments in the Royal Infirmary he took his M.D. in 1882. Then followed twenty-eight years of busy general practice in Burnley, and it was during these years that he made the greater part of the observations which made his fame. It soon struck him, as it must strike many medical men, that for the diagnosis and treatment of a vast proportion of illness, his teachers had been unable to give him anything like adequate guidance Mackenzie, greatly stirred by discontent, set himself to the filling of some of the gaps, and two examples of this pioneer work may be mentioned The value of pain as a guide to diagnosis was realised when he found that it was referred from the offending organ to particular areas of the surface of the body through the agency of the nervous system, and that the organ was not itself painful. This fundamental change in the conception of pain was independently discovered and extended by Dr Henry Head. Another gap so brilliantly, almost completely filled, was the classification of the irregularities of the heart. For this purpose Mackenzie invented a clinical polygraph for recording not only the pulse but also simultaneously the venous pulse in the neck. It thus became possible for the first time to observe the action of the auricle, which proved a key to the elucidation of arrhythmia. Irregularities and murmurs were shown to be significant or insignificant by the rational, though laborious, method of following cases exhibiting them for years until their degree of importance became manifest.

Great interest was aroused at home and abroad by the immediate value of these discoveries, and when Mackenzie relinquished his general practice at Burnley in 1907 to take up consulting work in London, he was recognised as the foremost investigator and authority in the world on heart disease. His popularity as a consultant was not allowed to interfere with research, which was continued first at the Mount Vernon Hospital and later at the London Hospital. The action of digitalis in disease was studied to such purpose that, as Prof. Cushny has said, "more progress was made in fifteen years than in the preceding century." The impetus of progress was given to disciples from all over the world, and to them were opened fields of thought and work which seem sufficient for a generation.

When the War came, Mackenzie initiated through the War Office a special hospital for the elucidation of problems connected with "soldier's heart." In 1918 he retired from consulting work and went to St Andrews, where he founded the Institute for Clinical Research. He had realised that attention was habitually directed to fully developed disease, so that, as he said, patients seemed to be admitted to hospital when they had the physical signs of obvious disease and might almost be described as incurable He determined to study afresh the nature of symptoms as met with in practice, so as to learn of disease in its early and perhaps curable stage. As time went on, he foresaw that the phenomena of disease might be governed by simple laws which he formulated as a basis for further examination by his colleagues at the Institute. Then his health failed, but not his faith and courage, and he finally retired to London, where he died on January 26.

Mackenzie's personal qualities were an ornament to the greatness and originality of his mind, and endeared him to all his pupils. He was indefatigable himself, an inspiring and generous master, a superman, but none was more human. His personality will remain as worthy of admiration as was his relentless pursuit of knowledge, not only for its own sake but also for its application in the relief of suffering humanity

In 1911 Mackenzie was appointed physician to the cardiac department of the London Hospital. In 1915 he became a fellow of the Royal Society, and received the honour of knighthood; later he was appointed honorary consulting physician to the King in Scotland. His most important works are "The Study of the Pulse" (1902), "Diseases of the Heart" (1908), "Symptoms and their Interpretation" (1909), "Principles of Diagnosis and Treatment in Heart Affections" (1916), and "Angina Pectoris" (1923).

MR. WILLIAM WATSON.

WE regret to announce the death of Mr. William Watson, which occurred at St. Albans on January 30. He was well known in botanical and horticultural circles through his long tenure of the curatorship of the Royal Botanic Gardens, Kew, a position he held from August 1901 until June 1922

Mr. Watson was born at Garston, near Liverpool, on March 13, 1858, and received his first appointment at Kew in 1879, following several years' experience in trade establishments His knowledge of tropical and sub-tropical plants was probably unrivalled. For many years he was a regular contributor to the

horticultural press, and so long ago as the eighties of last century wrote a valuable series of articles on the Palmaceæ in the *Gardener's Chronicle*. These articles it was hoped might have been republished in book form as a monograph of this natural order, thereby bringing Berthold Seemann's work on the same family up-to-date. This hope, however, was never fulfilled. To vol. 15 of the *Annals of Botany* he contributed an illustrated paper "On the germination of *Bertholletia excelsa*," the Brazil nut.

In later years Watson took a keen interest in the Cactaceæ and succulent plants generally, and his "Cactus Culture for Amateurs" is the standard work on its subject. He also wrote books on "Climbing Plants," "Rhododendrons and Azaleas," and, in collaboration with W. J. Bean, "Orchids, their Culture and Management," all of which met with success On horticulturists in general he conferred a great boon by editing a new edition of "Thompson's Gardener's Assistant," so much improving it that it became practically a new work For upwards of twenty years he was editor of the garden section of the *Field* His life's work, however, was centred in Kew, an institution which owes very much to his forty-three years' devoted service. He was elected an associate of the Linnean Society in 1904

THE *Chemiker-Zeitung* reports the death on January 6, at the age of sixty-eight, of Dr. Wilhelm Borchers, professor of metallurgy and electrometallurgy at the Technische Hochschule of Aix-la-Chapelle. Borchers was born at the university town of Erlangen, and after completing his studies there, he spent the next four years in a chemical factory as process chemist. The experience thus gained was of immense value to him in his later career as an investigator, for it enabled him to bring to a successful conclusion many difficult researches in the field of electrometallurgy. In 1891 he was appointed lecturer in chemistry and metallurgy at Duisburg, and six years later he was transferred to the Hochschule at Aix-la-Chapelle. His chief interest lay in the application of electrolytic processes to metallurgical problems, such as the production of metallic calcium, strontium, titanium, cerium, etc. He also conducted numerous researches on the preparation and properties of alloys. Prof. Borchers was the author of several books on electrochemistry, and in 1894 he founded the *Zeitschrift fur Elektrochemie*, which he edited until 1900. He also collaborated with Nernst in publishing the *Jahrbuch der Elektrochemie*.

WE regret to announce the following deaths:

Prof Walther Dieckmann, of the Department of Chemistry in the University of Munich, on January 12, whilst carrying out a research in organic chemistry in the State laboratory

Miss Lilian Suzette Gibbs, known for her work on the mountain flora of Australasia and on problems relating to the geographical distribution of plants

Dr. E E Klein, F R S, formerly lecturer on advanced bacteriology in the Medical School, St. Bartholomew's Hospital, on February 9, aged eighty.

Current Topics and Events.

INTEREST in the therapeutics of consumption has again been roused by the reports of successful treatment, this time by a chemotherapeutic agent which, under the name of sanocrysin, has been investigated by Møllgaard, a professor in the Landbohojskole of Copenhagen. There is no mystery chemically about sanocrysin It is sodium aurous thiosulphate ($Na_3Au(S_2O_3)_2$) which has long been known as Fordos and Geles salt. Years ago it was shown that gold salts have a powerful action on tubercle bacilli *in vitro* and several gold preparations, simple and complex, have been tried therapeutically with indifferent success. Møllgaard affirms that sanocrysin inhibits the growth of tubercle bacilli in a dilution of 1 . 1,000,000 and that their progress may be completely arrested in a concentration of 1 · 100,000. In non-tuberculous animals sanocrysin is said to be relatively harmless, whereas in tuberculous subjects very stormy reactions follow its exhibition and may actually end in death. It is believed by Møllgaard that these violent effects are to be attributed to certain poisons, of a tuberculin character, which are liberated from the dying and dead tubercle bacilli from the action of the sanocrysin rather than to a direct toxic action of the thiosulphate. It is said that the violent reactions can be lessened or prevented by the administration of an anti-serum produced by the injection of tubercle bacilli or its products. The sanocrysin treatment is really a twofold process. There is supposed to be the direct bactericidal action of sanocrysin and the neutralisation of its poisonous results by an antitoxin of sorts. The Møllgaard treatment has been applied for a considerable time both in cases of tuberculous human beings and animals, but judgment must at present be reserved as to whether it is likely to occupy a permanent place in tuberculo-therapy.

IN the course of his fourth talk on "Ether and Reality" given under the auspices of the British Broadcasting Company at the London station, 2LO, on February 17, Sir Oliver Lodge discussed magnetism and its analogies with life and knowledge. Sir Oliver stated that electrification is a matter of transfer, a transfer of pre-existent charges, a disturbance of equilibrium. When equilibrium is established, opposite charges are close together and disappear from our ken. They never go out of existence: we neither create nor destroy. The same is true for magnetism: we can make a magnet, but the magnetism was there beforehand. Magnetic lines of force differ from electric lines in being always closed loops; all we do is to open them out. They tend to shrink, and thereby pull together two things round which they are looped, like an indiarubber ring. They never shrink up to nothingness. One magnet can produce any number of others, for there is no limit to the amount of magnetisation; what one body gains, the other does not lose. In that respect it is analogous with life. Knowledge in this respect is like life and magnetism: there is an unlimited reservoir from

which to draw, and the imparting of knowledge does not lessen the amount possessed by the imparter; it is transferred without loss, though doubtless with the expenditure of some energy Knowledge grows from more to more. By diffusion it is increased, what one gains, another does not lose A magnet which has excited other magnets may be even stronger than before; life which has excited other life may still be vigorous. So far as we learn from science, nothing goes out of existence, it only changes its form and may become inappreciable to our senses.

A COGENT restatement by Dr R P Scott of the case for co-operation between England and China on certain lines and under certain safeguards appears in the current issue of the *Contemporary Review* Those who are best acquainted with conditions in China are by no means so pessimistic as to the outcome of the present situation as the political news appearing in the Press might appear to demand Private advice from China, however, indicates that this news is by no means exaggerated and that the social and commercial situation is serious Dr Scott lays great stress upon the pre-revolutionary character of Chinese ideals in pressing that side of his argument which rests upon the fundamental similarities between the English and Chinese mentality These, he holds, find their most significant expression in the qualities characteristic of the English "gentleman" and the Chinese "princely man," as well as in business faculties, and in humour Granting that co-operation is both possible and desirable, of the various suggestions put forward there is much to be said in favour of education as the field Dr Scott points out that it is the only one in which continuity can be obtained, and further, it is one to which each of the parties brings something distinctive—the Chinese, a thoroughness of mental grasp, and the English, breadth of outlook. Without attempting to displace literary studies, we could add instruction in those branches of science, especially the higher branches of physics and of surgery, for which the racial characteristics of the Chinese are peculiarly apt, but in which at present they lack opportunities of training. Dr Scott quotes a letter from the Chancellor of the National University of Pekin which should set at rest any doubt as to the willingness of the Chinese themselves to co-operate in this field. While Chinese ethical standards must be respected, what is needed in the opinion of the Chinese themselves is the spirit and tradition of our best public schools. Dr. Scott concludes by indicating in outline the means of attaining this object through joint membership of the Foreign Office Advisory Committee contemplated by the Bill for dealing with the Chinese Indemnity now before Parliament, and by joint committees in China itself.

IN the *Electrician* for February 6 some results are given of radio signal measurements between Great Britain and the United States made during the eclipse, which supplement the communication from Dr. W. H. Eccles on p. 260 of this issue. The experiments were carried out in Great Britain by the General Post Office, the Radio Research Board, and the International Western Electric Co. In the United States the Radio Corporation transmitted special signals from an experimental station situated at Rocky Point, Long Island. In Great Britain the Leafield and Northolt stations sent signals Similar observations were made on the day preceding and the day following the eclipse. Measurements were made both of the intensity and the apparent bearing of the signals On the day of the eclipse, there was a well-defined rise to a very sharp maximum of the signal intensity. This was followed by an equally well-defined minimum. The rise corresponded approximately to the intersection of the path of the beginning of the eclipse with the great circle passing through the transmitter and the receiver The minimum of signal intensity coincided to within one or two minutes with the intersection of the path of totality with the corresponding great circle. The radio bearings of Rocky Point were observed at Slough on January 24 and 25 and were found to be very steady in each case There was no appreciable effect that could be attributed to the eclipse Observations were also carried out at Slough on the signal intensity and bearings of Leafield, which is distant 48 miles In this case the erratic behaviour of both measured quantities was very marked. These variations are a normal daily occurrence at this period of the year and neither of the measurements seemed to be affected by the eclipse

THE Wireless Telegraphy and Signalling Bill which has been introduced in the House of Commons by the Postmaster-General, Sir William Mitchell-Thomson, is a measure of such questionable quality and scientific detriment that it is scarcely likely to pass through Parliament without substantial change The Bill is particularly objectionable from the point of view of the scientific investigator and inventor, as by it officials from the Post Office may demand, under heavy penalties, to enter any laboratory and inspect apparatus and experiments even though these do not involve any outside transmission True, this oversight of experimental work is claimed already as being in departmental regulations, but these could never be upheld The new Bill, however, would make it possible for the Postmaster-General to impose them on any experimenter or inventor. What the Bill provides for specifically is control of "the installation and working of apparatus for utilising etheric waves as they apply to the installation and working of apparatus for wireless telegraphy" Mr A A. Campbell Swinton points out in a letter in the *Times* of February 17 that a candle or any other source of radiation is producing "etheric waves" and that, as the existence of the ether itself is now questioned in certain scientific circles, much interesting litigation might be anticipated if the words now in the Bill are retained without statutory qualification. So many objections have, however, been raised to some of the clauses, as they stand at present, that the measure must meet with considerable opposition when it is under discussion in Parliament.

WE have received from Prof. G Friedel, of Strasbourg, a somewhat lengthy communication in which he maintains that his classification of Lehmann's so-called liquid crystals is valid. He calls this state of matter "mesomorphic" and so early as 1911 recognised that this embraced two distinct forms which he then called "liquides à conique" and "liquides à fils" He supposes that in the former there is a kind of periodicity in the sense that the molecules are distributed irregularly in parallel equidistant layers In the latter there is no periodicity at all, but only a general parallel orientation of the molecules. These valuable conceptions sharply differentiate the mesomorphic states from the complete periodicity of true crystals on one hand and from the complete irregularity of amorphous bodies or liquids on the other In 1922 he re-named the two states "smectique" and "nematique" (from σμῆγμα, soap, and νῆμα, thread, from the thread-like appearance of the sharp boundaries of different portions observed in polarised light under the microscope) He suggests that the English name for the former should be derived from the French rather than that the existing English word "smegmatic" (derived from the original Greek) should be used He differs strongly from McBain in holding that such bodies as soap curds do not consist of crystals but are mesomorphic, and it is for this reason that he no longer uses the designation "liquid" If, as affirmed by McBain (see photograph in NATURE of July 12, 1924, p 49), there is at least one other form of soap which may be described as a "conic anisotropic liquid," this would merely show that the same body can exist in several different "smectic" forms This, however, leaves scope for speculation as to how to explain these different varieties.

ALTHOUGH a number of investigators using X-rays have failed to obtain radiograms with any liquid crystals except for soap curds, the classification of which is in dispute, Friedel maintains that this is due to faulty technique in the case of smectic bodies such as transparent soap solutions, whereas no nematic body should give such a radiogram He announces that his son, E Friedel, has now obtained such a radiogram with ethylazoxybenzoate. Publication of this evidence will be awaited with interest. Friedel appears, however, to be mistaken in his assertion that radiograms of soap curds disclose only one set of planes, Piper (J. Phys. Soc., 1923, 35) found three spacings, namely, one wide spacing of the order of 4Å and two of the order of 4Å. R. E. Gibbs (J Chem Soc., 1924, 125, 2625), referring to the higher fatty acids, the X-ray photographs of which resemble the soap curds, remarks: "Owing to the doubt that has existed as to the nature of the fatty acids, it is of interest to note that, since this paper was written, further work has been done with stearic acid showing it to be of a true crystalline nature and demonstrating its extinction directions and brush figures. Several single crystal X-ray photographs of it have already been taken."

THREE Cantor Lectures, on January 19, 26, and February 2, were delivered at the Royal Society of Arts on "Radiological Research—A History," by Mr. V. E Pullin, Director of the Radiological Research Department, Woolwich. Mr. Pullin said that radiological research may be said to have begun in the year 1705 with the experiments by Mr. Hawksbee, F R S, on electrical discharges in vacua, followed by those of Mr William Morgan in 1785, the latter probably the first experimenter to produce X-rays. The great advance in knowledge made by scientific workers during the nineteenth century, particularly Faraday and Sir William Crookes, paved the way to the sensational discovery of X-rays by Rontgen at the end of 1895 The controversy as to the nature of the cathode stream was eventually settled by the classical work of Sir J. J Thomson in 1897 The nature of the X-rays was finally determined when, aided by Planck's theory of radiation, Prof von Laue was able to show that X-rays could be diffracted by means of crystals The accidental discovery of X-rays by Rontgen in 1895 was due to his use of fluorescent screens Much important research during the next crowded years resulted in Sir Herbert Jackson's use of a concave cathode, Mr Campbell Swinton's platinum target, and the introduction of the vacuum regulators gave us the modern gas-tubes, leading up finally to the introduction in 1913 of the Coolidge tube To-day it is possible to operate a tube on 200,000 volts and to examine castings 3 in thick Voltages up to 400,000 are already available at Woolwich, but no X-ray tube can stand up to more than 200,000 volts owing to vacuum and other difficulties These difficulties may call for a new type of tube, and research on this subject is now being carried out at Woolwich Modern research is also being directed on the problem of focussing, and design of very high tension direct current electrical machines Radiology should be the indispensable adjunct of all modern engineering practice, owing to the great saving that can be effected by detection of flaws in heavy castings, before expensive machining has been done During the previous week, with some new apparatus, designed and made at Woolwich, a mass of steel 4 in. in thickness was penetrated. This constitutes a record in penetration.

DR. J. H. JEANS, Secretary of the Royal Society, and Sir William Henry Ellis have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

SIR WILLIAM HARDY and Miss Ida Bircumshaw will deliver the Bakerian Lecture at the meeting of the Royal Society of March 19. They will take as their subject "Boundary Lubrication. Plane Surfaces and the Limitations of Amontons' Law."

THE Council of the Chemical Society has nominated Dr. Arthur W. Crossley as president, Dr. T. Slater Price as secretary, and Prof. F. G. Donnan as foreign secretary. The annual general meeting will be held on March 26 at 4 P.M., and the anniversary dinner will be held the same evening at the Hotel Victoria, Northumberland Avenue.

SIR THOMAS H. HOLLAND has been elected president, and the Rt. Hon. Viscount Cowdray of Cowdray, Sir John Cargill, Bart., Mr Alfred C. Adams, Mr. Alexander Duckham, Mr Arthur W Eastlake, and Mr. Robert Redwood have been elected vice-presidents of the Institution of Petroleum Technologists for the ensuing year.

THE International Health Board of the Rockefeller Foundation has made a grant of 1,100,000 kröne (about 62,000*l.*) to the Danish State Serum Institute at Copenhagen for the purpose of extending the building and laboratories. This is the third grant made to Denmark by the Rockefeller Foundation during the last year or two Previous grants were allocated to the Veterinary School and to Prof. Niels Bohr

THE following officers of the Royal Astronomical Society were elected at the anniversary meeting on February 13 *President*, Dr J. H Jeans, *Vice-Presidents*, Dr A. C D Crommelin, Dr J L E Dreyer, Prof A Fowler, Dr J. W. L. Glaisher; *Treasurer*, Lieut.-Col F. J M Stratton, *Secretaries*, Dr. J. Jackson, Rev. T. E R Phillips, *Foreign Secretary*, Prof H. H Turner

ON Thursday next, February 26, at 5 15, Sir Arthur Smith Woodward will deliver the first of two lectures at the Royal Institution on dinosaurs, and on Saturday, February 28, at three o'clock, Sir Ernest Rutherford will begin a course of four lectures on the counting of the atoms. The Friday Evening discourses on February 27 and March 6 will be delivered by Sir James Irvine, on sugars from the point of view of the organic chemist, and by Sir Arthur Keith, on the rate of man's evolution, respectively.

AT the annual general meeting of the Meteorological Society on January 18, the following officers were elected *President*, Mr C J P. Cave, *Vice-Presidents*, Dr. C. Chree, Mr J S Dines, Mr. L F. Richardson, Mr. Gilbert Thomson, *Treasurer*, Mr Francis Druce; *Secretaries*, Mr. Richard Corless, 21 Wimborne Gardens, W Ealing, W.13; Commander L. G. Garbett, Meteorological Office, Air Ministry, Kingsway, W C.2; Major A. J H. Maclean of Ardgour, Ardgour, Argyllshire; *Foreign Secretary*, Mr R G. K. Lempfert, 24A Trebovir Road, S.W 5, *Assistant Secretary*, Mr. A. Hampton Brown, 49 Cromwell Road, South Kensington, S.W 7.

THE discovery of a new urinary antiseptic by the Johns Hopkins School of Hygiene and Public Health is announced in the *Times* of February 12. Hexylresorcinol, as the new compound is named, is the outcome of several years' work by Dr. Leonard, of the National Research Council, in collaboration with Dr. Treat Johnson, professor of organic chemistry in Yale University. It is stated to be a potent antiseptic for the treatment of infections of the kidneys and urinary tract, long-standing infections of the kidneys clearing up under its use in 48 hours. The cures appear to be permanent, and no ill effects were observed.

THE Royal Society has now been notified that His Majesty's Treasury proposes to make provision in the Estimates for 1925–1926 for an increase of the Royal Society Publication Grant from 1000*l.* to 2500*l.* in the current year. This grant is available for helping the publications of other scientific societies as well as for assisting the separate publication of books, memoirs, etc, of a scientific nature Applications for grants for the current year will be considered by the Council of the Royal Society at its meeting early in July Applications from societies will be received by the secretaries of the Royal Society, those from individuals should be brought forward by members of Council

Two noteworthy gifts, for research and for education, are announced by the New York correspondent of the *Times* A fund of 600,000*l* has been raised for the establishment at Johns Hopkins University of a centre for ophthalmological research to be called the Wilmer Institute. The General Education Board has given half the money and the remainder has been subscribed by friends and former patients of Dr William Holland Wilmer, of Washington, who will retire from private practice to assume direction of the new centre. The other announcement is of a gift of 100,000*l.*, by Mr Cleveland H Dodge, of New York, to the fund for the Near East Colleges The institutions which benefit by the gift are the Robert College, Constantinople, the American University of Beirut, the Constantinople Women's College, and other institutions at Smyrna and Sofia The gift is sufficient to cover a fifth of the working expenses of the colleges for the next five years

A MEMORANDUM on the probable character of the weather in north-west India in January, February, and March has recently been issued by Mr. J H Field, the officiating Director-General of Observatories for the Government of India The forecast states that "the winter rainfall of north-west India together with the snowfall on the western Himalayas may be expected to be normal or in slight excess" These winter rains are brought by a series of depressions from south-west Europe and the Mediterranean The tendency for persistence in the winter affords indication for the later months to be based on the weather in December. The application of statistical methods to seasonal forecasting in India has been very definitely studied, and with considerable success In addition to the factors which have been in use for some time past, another feature which seems likely to prove of importance is the seasonal change of the upper air currents in northern India at a height of 4 miles above ground obtained from observations at Agra.

THE report of the Council of the Optical Society submitted to the annual general meeting of members on February 12 shows that the efforts of the Society to promote and advance the theory and practice of optical science are being well maintained. The steadily increasing interest that is being taken in this subject is evidenced not only by the nature and number of the papers presented to the Society, but also by the interest taken in the Society's Transactions, in which these papers are printed. By means

of special exhibits and demonstrations at recent meetings, attention has been directed to instruments and apparatus of historic interest as well as to modern developments of various optical instruments The financial position is now so satisfactory that a further extension of the Society's activities is under consideration The following officers have been appointed for the current session. *President*, Mr. T Smith, *Vice-Presidents*, Instr.-Comdr. T. Y. Baker, Prof Archibald Barr, Sir Frank Dyson; *Hon. Secretaries*, Mr F F. S Bryson, Prof A F C. Pollard, *Hon Treasurer*, Major E O. Henrici; *Hon Librarian*, Mr J H Sutcliffe, *Editor*, Dr J. S Anderson

"TAKING a Museum to School" is the heading of an article in the *Manchester City News* of February 7 It describes a scheme which has been inaugurated by the Salford Museum for the distribution to schools of portable cases containing natural history specimens, photographs of trees, types of architecture, furniture, etc The underlying principle is sound though by no means new The idea has been greatly elaborated by the American Museum of Natural History, and in 1922, 475 schools were supplied with sets Of course, in a large museum where the staff is adequate, or when there are official guide lecturers, it were better to bring the classes to the museum When such is not possible, then exhibits may, with great advantage, be sent to the school. The cases thus supplied may show birds, animals, and so on, which children would not otherwise see, and may encourage them to visit the museum itself and so extend their knowledge But the great difficulty is the "text" accompanying the cases Such exhibits placed in the hands of teachers having no special knowledge of the subject may tend to grave misconceptions, whereas a stereotyped lecture may become irksome. Children have a way of asking peculiar questions. Before receiving such cases the teachers should have a "lesson" themselves, given by the person responsible for the exhibit

ON February 26 occurs the bicentenary of the birth of Nicolas Joseph Cugnot, the French military engineer who built the first vehicle driven by a steam engine Born at Void in Lorraine in 1725, Cugnot joined the French army, served in the Low Countries, and afterwards in Paris gave lessons in military affairs In 1766 he published his "Éléments de l'art militaire ancien et moderne" and three years later a volume on fortification He appears to have made two steam vehicles, the first in 1769 and the second in 1770 The earlier was put into motion in the presence of the Duc de Choiseul, then Minister of War, and of General Gribeauval, and it carried four persons Its steaming capacity, however, was very small, and it had to stop at short intervals to allow the steam pressure to rise. The demonstration led to the construction of a second vehicle at the Paris Arsenal, and this is now preserved in the Conservatoire des Arts et Métiers. It is doubtful if this vehicle ever ran. Intended for the transport of artillery, it was designed to carry a load of about 4½ tons at a speed of 2½ miles per hour and cost 800*l*. Though designed by Cugnot it was made by Brezin. General Morin in 1851 gave an interesting account of the machine to the Paris Academy of Sciences Cugnot continued to reside in Paris until the Revolution, when he went to Belgium. Poverty appeared to have dogged his steps, but under the Consulate he was given a small pension of 1000 livres, and he returned to Paris, where he died on October 4, 1804

IN a discourse delivered before the Royal Institution on February 13 on the forces of law and order in a primitive community, Dr B Malinowski gave an account of his conclusions in regard to primitive law arrived at during his years of field-work among savages in Melanesia In his opening remarks he referred to the Imperial value of anthropological studies for the government of savage races, and said that such studies must be directed to the actual and practical problems of savage life in order to be useful. The real task of the administrator is legislation and the meting out of justice to the natives, and the most important practical subject of anthropology should be primitive jurisprudence Upon this question anthropology hitherto has often been silent and sometimes even incorrect. Nothing could be more misleading than the statement frequently made that "all societies have passed through a stage of communal ownership and communistic sexual relation" Taking Melanesia, Dr. Malinowski showed that, in spite of most illusive appearances, the ownership of property is strictly defined and there is no trace of real communism. The so-called communism is the result of the observers looking at native custom through European eyes Another legal dogma constantly used by some modern anthropologists is "The clan or kin is the unit in primitive law and not the individual" Exogamy is usually quoted as the most perfect index of the homogeneity of the clan This again is an illusion. Dr Malinowski urged that it is in this type of anthropological analysis of savage institutions that the anthropologist can join hands with the administrator in working out a practical science of administrative anthropology.

ARRANGEMENTS are in progress for the next annual meeting of the British Association, to be held in Southampton on August 26-September 2, under the presidency of Dr. Horace Lamb, formerly professor of mathematics in the University of Manchester. Presidents of the several sections have been appointed as follows: *Mathematics and Physics*, Dr. G. C. Simpson, director of the Meteorological Office; *Chemistry*, Dr. C. H. Desch, professor of metallurgy in the University of Sheffield, *Geology*, Prof. W. A. Parks, of the University of Toronto; *Zoology*, Mr. C. Tate Regan, keeper of zoology in the British Museum (Natural History); *Geography*, Mr. A. R. Hinks, secretary of the Royal Geographical Society; *Economics*, Miss Lynda Grier, principal of Lady Margaret Hall, Oxford; *Engineering*, Sir Archibald Denny, Bart.; *Anthropology*, Dr. Thomas Ashby, director of the British School at Rome; *Physiology*, Dr. A. V. Hill, professor of physiology in University College, London; *Psychology*, Dr. C. E. Spearman,

Grote professor of the philosophy of mind, University of London; *Botany*, Prof. J. Lloyd Williams, of University College, Aberystwyth; *Education*, Dr W. W. Vaughan, headmaster of Rugby; *Agriculture*, Dr. J. B. Orr, head of the Rowett Research Institute, Aberdeen. Among the principal items already set down for discussion are transport problems, to which the Sections of Economics and Engineering will devote two days, with special reference to the railway centenary of the present year; the cost of farming and the marketing of agricultural produce (Sections of Economics and Agriculture); the functional significance of size (Zoology and Physiology), the ignition of gases (Chemistry and Engineering); tidal lands (Geography and Botany); variations in gravitational force and direction (Physics and Geology), recent investigations upon vocational guidance (Psychology and Education); the distribution of animals and plants in relation to continental movements (Geology, Zoology, and Geography), the acquisition of muscular skill (Physiology and Psychology), and discussions on health in schools, the disciplinary value of subjects, the training of teachers, and the teaching of biology. Prof. Parks, of Toronto, as president of the Geological Section, succeeds the late Dr Willet G. Miller, the Ontario Government mineralogist, who was to have occupied the chair of the Section.

WITH the January number the *Illuminating Engineer* begins a new stage of its existence Formerly it was merely the official organ of the Illuminating Engineering Society; it has now been extended so as to appeal to a much wider class of reader This number is brightly written and shows that good methods of illumination are of general interest. During last year no very striking progress was made in inventing new lamps or incandescent mantles, but considerable progress was made in the methods of applying illuminants. It is considered that the time has come to enlighten the public as to what is being done. Playing games by artificial light, lighting developments at the Zoological Gardens in Regent's Park, the psychology of illumination, lighting and tobacco, inadequate lighting and defective vision, illuminated name plates for motor cars, and artistic illumination are only a few of the subjects discussed. We were specially interested in the "possibilities and limitations" of motor-car headlights. It is pointed out that the glancing beam of the headlight does not show to the driver puddles of water in the road During the floods of December, inability to locate fairly deep water ahead often proved embarrassing This shows that headlight illumination is far from perfect

IN our issue of February 14, p 242, reference was made to an article by Mr. F W Shurlock on the Rev A Bennet, F R S., in the January number of *Science Progress* Mr Shurlock writes to point out that the statement that Bennet died at Fenny Bentley is inaccurate He held the rectory of Fenny Bentley concurrently with the curacy of Wirksworth, where he lived, died, and was buried, a memorial tablet is in the church, on the south wall of the nave

AN assistant is required in the new chemical laboratory of the City Analyst for Leicester The work of the person appointed will be mainly in connexion with the analysis of food and drugs, water and sewage effluents The latest date for the receipt of applications by the Medical Officer of Health, Leicester, is Thursday, March 5.

ERRATUM.—In NATURE of February 14, p 236, column 2, line 46, for words "that is" read "at all events"

Our Astronomical Column.

THE LUNAR ECLIPSE OF LAST AUGUST.—*C.R. Acad. Sci.* of Jan. 19 contains a research on the brightness of the moon at this eclipse, made by J. Dufay and A. Conder at St. Geniez (height 3500 ft.) in a clear sky. They used the Dufay photometer, which gives results that are independent of the diameter of the body measured. The moon was compared with Mars and Jupiter, the magnitudes of which were taken as −2·6 and −1·8. In the following table D is the distance in minutes of the moon's centre from the centre of the shadow, V its visual and P its photographic magnitude, C the colour-index.

D	V	P	C	D	V	P	C
10′	−0·9m	... m	m	18′	−1·35m	+0·7m	2·05m
12	−1·0	+3·2	4·2	20	−1 65	0·0	1·65
14	−1·1	+2·3	3·4	22	−2 1	−0 7	1·4
16	−1·2	+1·4	2·6	24	−2·7	..	..

The increase of red in the centre of the shadow is very noticeable, and was also observed in the telescope, the outer portion of the umbra being greenish grey, the next zone orange-red, the centre brownish red.

The colour-index of Mars was determined as 1·37m ±0·06m. It presumably varies with the character of the markings on the disc at the time.

Comparison was made with the eclipse of Oct. 16, 1921, observed by M. Danjon. It was concluded that the moon in 1921 was four times as bright as in 1924, presumably owing to greater cloudiness in the earth's atmosphere in 1924

ASTROGRAPHIC ZONE 21° SOUTH (HYDERABAD).—The Hyderabad Observatory (Director, T P Bhaskaran) has shown most praiseworthy zeal and energy in completing not only the zone originally undertaken but also the zone −21° to −23°, which had been undertaken by two other observatories in turn, but abandoned by both of them. It was thanks to the liberality of the Nizam and his Government that this extension was possible. The present volume contains the measures of stars on the plates the centres of which are in declination 21° south. The average number of stars per plate is 491, a higher average than in previous zones; this is ascribed to improvement in the quality of the plates Plates were rejected that did not show at least twice as many stars as Schönfeld's map. In the galactic zones, some fifteen times as many stars are measured as are contained in the map, although the measurers were instructed to pass over the very faint stars in these regions.

The catalogue contains the measured diameters, with data for deducing the magnitude, and the x, y co-ordinates to 3 decimals of a réseau interval; also provisional plate constants for reducing to R.A. and decl. The plates in the present volume were exposed between Dec. 1920 and June 1923.

Research Items.

PSYCHO-ANALYSIS AND MOTHER-RIGHT.—In *Psyche* for January, Dr B. Malinowski concludes his examination of the applicability of the Freudian theory of the Œdipus complex to a society organised on a matrilineal basis. In his previous contribution to this subject (*Psyche*, April 1924) it was shown that whereas under the *patria potestas* the conflict is concerned with father and mother, in the matrilineal family of the Trobriands, it affects the sister and the mother's brother. Turning now to the question of disease and perversion, it appears that among the Trobrianders, where sexual desires are allowed a natural outlet at an early age, perversions and neurotic affections are comparatively rare, while in the Amphletts, where sexual license is repressed, they occur with frequency. The evidence of dreams, distinguishing "free dreams" from "official dreams" of a divinatory or magical character, points to repressed desire in the direction of the sister. This form of incest is regarded with such horror that at first sight it might appear never to occur, but careful investigation has revealed that it does exist. Both obscenity and myth bear this out. Abuse by attribution of mother and sister incest, though both actions are abhorrent to the Trobriand mind, in the degree of resentment it arouses indicates that there is a real temptation to break the strong taboo against the sister. In the same way, throughout the myths of the Trobrianders there runs a strong matrilineal complex; in the tales of origin, no father appears, and when a male member of the family is mentioned in such a manner as to indicate a conflict of some kind, it is the maternal uncle.

THE PROBLEM OF ARISTOTLE.—Prof. Burnet's British Academy "Master-mind" Lecture ("Aristotle," Oxford University Press, 1*s*.) is of more than usual interest, not only to classical and philosophical students but also to men of science. Aristotle's real greatness, Prof. Burnet tells us, was as a biologist. The most important formative period of his life was the middle period, the years when he was lecturing at Assos and afterwards when he removed to Mytilene in Lesbos, where he made his careful observations and studies of marine forms of life. Prof. Burnet refers to the recent important work of Prof. Werner Jaeger of Berlin ("Aristoteles, Grundlegung einer Geschichte seiner Entwicklung"). The conclusions of this book are in accord with Prof. Burnet's own independent studies of the problem, though he differs from the author on some points of minor importance. The curious problem about Aristotle is that scarcely any of the works we possess, and none of the important ones, were published in his lifetime or intended for publication, or in a form in which he would have acknowledged them or consented to their publication. Yet it seems certain that they represent his mature views in a way which his published works did not. They are his written lecture notes, and they have been preserved by a strange accident, while his own published works, by which alone he was known in the first two centuries after his death, are lost. What Prof. Burnet brings out with exceptional clearness is that the contrast between Plato and Aristotle and the latter's criticism of the former's doctrine of forms is explained by the fact that, while Plato was exclusively interested in mathematics, Aristotle's attention was directed towards biology.

TERTIARY MAN IN ENGLAND.—A review of the evidence bearing upon the question of tertiary man in Britain by Mr. J. Reid Moir, appears in vol. xxiv., No. 6 of *Natural History* (American Museum of Natural History). The vast geological age of the Kentian eoliths finds support in East Anglia. There the White Coralline Crag, which is definitely earlier than the Red Crag, was laid down in a warm period, the deposition of the Red Crag beginning with the irruption of arctic waters. The Red Crag detritus contains material of different periods due to denudation, including eoliths of Kentian type, much rolled and abraded, and later forms of which the rostro-carinate is the outstanding implement. The Red, and Norwich Crags, and their underlying detritus bed, represent the first glacial deposit in East Anglia. The Foxhall implements belong to the Crag itself and are clearly later than the detritus bed implements, as is shown in the variation in patination when, as in several cases, the former has been made out of the latter, but implements of the same kind as are found at Foxhall occur at Thorington Hall *beneath* the Crag, where man evidently lived on a surface of London clay instead of Crag. The Cromer implements are to be regarded as Early Chellean, a classification supported by the fauna. In an appended note in the same publication, Sir E. Ray Lankester questions the use of the term "quaternary" to describe the strata later than pliocene, on the ground that they are adequately described as tertiary, as there is no separation of later deposit from pliocene as there is of tertiary from secondary and secondary from primary. The term pliocene should be applied to the White Coralline Crag on the ground of its Molluscan fauna in many respects identical with that of deposits distinguished by the marine "Pliocene"; while the Red Crag should be assigned to the Pleistocene, it being recognised that the shells, bones, and teeth of cetaceans and terrestrial mammals in the Suffolk Bone Bed, which were assigned by Lyell and his followers to the Red Crag, and its sea are derived from earlier strata and are not contemporary with the Red Crag.

THE PLEISTOCENE VERTEBRATE FAUNA OF NORTH AMERICA.—The Carnegie Institution of Washington has published (October 1924) an account, by Dr. O. P. Hay, of the pleistocene vertebrate palæontology of the region west of the Mississippi, a continuation of a previous account which dealt with the regions east and north of the river. The volume deals with the discovery of various groups of mammals, each group being taken separately, and the places where species of the group have been found are detailed in order for each province. More than a quarter of the account concerns the places where Proboscidea have been found, mastodons and, in particular, *Elephas boreas*, *E. columbi*, and *E. imperator*. Other groups detailed are the Xenarthra, horses, tapirs, peccaries, camels, deer, bison, and beavers. Twenty-nine maps illustrate the positions where material has been found, and an index, which is very complete, gives reference both to the animals and their localities. The work will be very useful for reference by any one studying the Pleistocene of North America as well as for purposes of comparison with the corresponding faunas of the Old World in questions of migration and distribution.

CARBONIFEROUS ROCKS IN CENTRAL JAPAN.—A recent issue of the Scientific Reports of the Tôhoku Imperial University at Sendai (vol. viii., No. 1) contains an important paper by Ichirô Haysaka "On the fauna of the Anthracolithic Limestone of Ômimura in the western part of Echigo." The paper has had a chequered career; originally written in 1920, the MS. was destroyed in the Tokyo fire that followed the earthquake of September 1, 1923, and

the whole work has been courageously rewritten since. The locality considered lies on the northern side of the Central Island, almost due north-west of Tokyo The formations represented by the thick mass of almost vertical limestone, about 2 km in thickness, there developed probably include the Permian down to the Tournaisian The fossil fauna comprises Foraminifera (including, of course, the well-known Fusilina), corals, Brachiopoda, Bryozoa, a crinoid, and a very few mollusca. Altogether, 41 species are recorded, but only four are regarded as new, while several are indeterminate. Representative specimens receive illustration on six plates of that standard of excellence which we have come to associate with Japanese productions, whilst there is, further, a map of the district giving the geological details. The author points out that the Lower Carboniferous formation of marine origin is almost absent from continental Eastern Asia—China, Korea and Manchuria—although it seems to be recognised in the province of Yun-nan, and has been reported from Central Asia What was the relation between the Lower Carboniferous waters of Central Asia and of the eastern border land is, as he remarks, a very interesting question

CHROMOSOMES OF WHEAT HYBRIDS.—Mr A E Watkins (*Journ. of Genetics*, vol 14, No 2) has made an important investigation of the chromosome behaviour in certain hybrid wheats. From earlier work of Sakamura, Kihara, Sax and others, the wheats are known to fall into three groups having chromosome numbers which are different multiples of 7 An intensive study was made of the chromosome distribution in the pollen mother cells of F_2 and F_3 plants derived from crossing Rivet wheat (*Triticum turgidum* var $2n = 28$) with varieties of *T vulgare* ($2n = 42$) The F_1 plants have 35 chromosomes, and two plants from later generations were especially studied, one having 31 chromosomes ($14 \times 2 + 3$) and the other 38 ($= 17 \times 2 + 4$). The history of the unpaired chromosomes is followed and the mathematical probability of the various types of pollen grains which will be formed, based on random distribution, is worked out From these observations and those of Kihara, it is found that plants with less than 35 chromosomes never have more than 14 bivalents, and in plants with more than 35 chromosomes the sum of the number of bivalents and univalents is always 21. One tentative explanation offered is that in these hybrid plants only pollen grains with 14 or 21 chromosomes function. There is evidence from other plants that the unpaired chromosomes are frequently or usually lost

THE CARBON BLACK INDUSTRY.—A few years ago the carbon black industry of the United States was one of the minor "side-lines" of natural gas production, and some peculiar state legislation very nearly killed it altogether, especially in Louisiana A new demand for this commodity, however, has arisen and has influenced operations to such an extent that the output for 1923 (during which year 138,262,648 pounds were produced) represented an increase of 104 per cent. over that obtained in the previous year. The cause of this remarkable spurt is the demand by the rubber companies manufacturing pneumatic tyres for motor vehicles; carbon black is thus employed with considerable advantage both to manufacturer and to user. Mr. G. B. Richardson, in Mineral Resources of the United States, 1923, part 2, gives figures to show that the average yield per thousand cubic feet of gas is 1·3 pounds of carbon black, and the estimated quantity of gas used for the purpose in 1923 was 109,096,000 thousand cubic feet. Louisiana, the most important producer in America, was responsible for practically 75 per cent. of the total amount, West Virginia and Kentucky yielding the next largest outputs It is interesting to note, however, that during the latter part of 1923 a state of over-production of this substance was reached, and as this corresponds with a period of great activity in the pneumatic tyre industry, we may gauge to some extent the possible economic limit to the manufacture of carbon black for this purpose and to the expansion of the industry The price of carbon black at the plant averages about 8 5 cents per pound

PHYSICAL CONSTANTS OF ICE.—The specific heats and latent heats of fusion of ice have recently been determined by O Maass and L J. Waldbauer (J Amer Chem. Soc, Jan 1925). The method used enabled measurements to be carried out at low temperatures. The specific heat of ice, determined at ten-degree intervals from $-180°$ to $0°$, was found to be accurately represented by the equation $c = 0.485 + 0.000914t - 0.00000546t^2$, the latent heat of fusion is 79·42 cal. per gram The specific and latent heats of some organic liquids were also determined, the results indicate that atomic heat is a highly constitutive property when the specific heat of a compound varies greatly with the temperature

THE SUN AND ATMOSPHERIC ELECTRICITY.—In the March and December 1924 issues of *Terrestrial Magnetism and Atmospheric Electricity*, Dr Louis A. Bauer has collected together and discussed the observations on atmospheric electricity made on undisturbed days during the past seven sunspot periods. He concludes that the atmospheric potential gradient and its daily and seasonal variations, and the air-earth electric current, are influenced by sunspots. As a rule the gradient and the ranges of its daily and seasonal variations are increased about 30 per cent by the change from minimum to maximum sunspot frequency, but there have been periods in which they have decreased, and in these periods terrestrial magnetic activity has also decreased The gradient and the ranges of its variation are greatest near the equinoxes and least near the solstices

GUN WIRE.—The system of wire-winding of guns first proposed in 1855 was introduced about 1890 with the object of effecting a distribution of the firing stresses in a more uniform way than could be attained by shrinkage alone The steels employed usually contained from 0·6 to 0 7 per cent of carbon, and British gun wire is in the form of a tape or ribbon 0·25 in wide by 0·06-0 04 in thick with rounded edges The steel is severely cold-worked, and exhibits a comparatively low elastic limit in spite of its high tensile strength, but it has long been recognised that this condition of imperfect elasticity in the wire under tension can be removed by a low temperature heat treatment We have received from the Research Department, Woolwich, R D. Report No 60 entitled "Gun Wire The Effect of Low Temperature Heat Treatment on the Properties of Cold-Strained Steel and Its Behaviour under Stress at Raised Temperatures" The work described was undertaken with the object of providing a material which would maintain a condition of constant stress with constant strain at a given temperature whatever the variation (within certain limits) of strain and temperature to which it was subjected in use The author, Dr. Greaves, as a result of his investigations, concludes that if it is required to ensure a constant tension in the wire at atmospheric temperature, in

spite of considerable variation in the temperatures to which it may be subjected in use, the wire must be heat-treated at a temperature not below 200° C The lower limit of the temperature of preliminary treatment (in excess of 200° C) is fixed by the fact that it must be above any temperature to which the wire is likely to be subjected in use On the other hand, the upper limit of temperature of treatment is governed by the tension which is to be maintained The higher the tension the less must the temperature of the treatment exceed 200° C. The report contains data from which the relation between stress, temperature, and preliminary treatment of the wire can be determined.

A VECTOR-TROLLEY APPARATUS.—Anything that makes the principles of mechanics more obvious to the student is sure of a hearty welcome from all teachers of the subject in schools and at universities. Considerable interest, therefore, attaches to the "Vector-trolley" apparatus designed by Mr E. J Atkinson, of the Harrow County School, and exhibited recently at the annual meeting of the Mathematical Association, and at the Royal Institution. The method is based upon the principle of the well-known problem in mechanics, where two masses, one

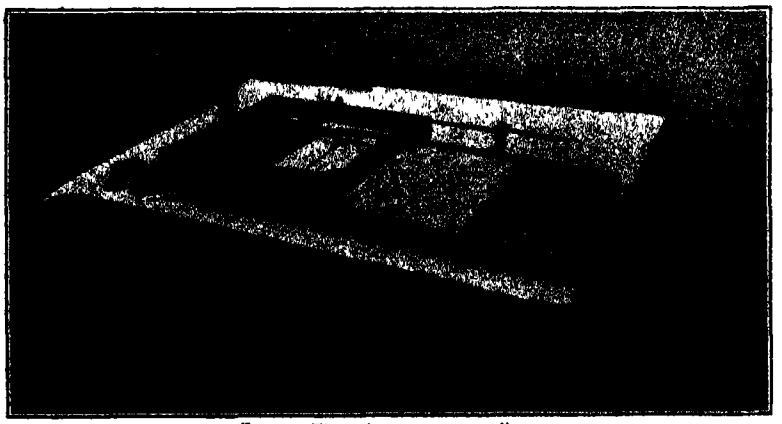


FIG. 1.—The Atkinson vector-trolley

moving on a horizontal table and the other falling vertically, are joined by a string passing over a fixed pulley. The motion is one of uniform acceleration, even if friction and the mass of the pulley are taken into account. If in this way motion is given to the mass on the table, and the hanging mass is disconnected from it, then, assuming smooth running, the mass on the table can be taken to move with constant speed for some considerable time The application of this principle by Mr Atkinson is made clear by means of the accompanying illustration (Fig 1), from which it is seen that two such accelerated or uniform motions in different directions are communicated to a registering instrument simultaneously. The angle between the two motions can be adjusted at will. Propositions like the parallelogram of velocities and of accelerations, the relationship $P = mf$, parabolic motion of the projectile, the theory of relative motion, can all be illustrated simply and convincingly. Mr Atkinson's method is very straightforward The mechanism is easily understood, and both the teacher and the student should find the use of such a mechanism of considerable value The apparatus is being manufactured by Messrs. Cussons, Ltd., of Manchester.

FORGING TEMPERATURE OF STEELS.—It is well known that, in the case of steel, forging is most effective at a certain favourable temperature which is neither too high nor too low. This is called the forging temperature. As yet no method has been discovered for measuring the forgeability of a metal. Prof. Kotaro Honda has addressed himself to this problem, and in the eighty-first report from the Research Institute for Iron and Steel and other Metals, Sendai, entitled "On the Forging Temperatures of Steels," he concludes that forgeability can be adequately measured by the elongation obtained in a testing machine. He gives reasons for considering that the mechanism of the elongation due to longitudinal tension and lateral compression must be the same, and finds that, in the case of carbon steels, the elongation temperature curve has generally two maxima and two minima. The temperatures of the maxima are at 760° and 1200° C., this latter being the temperature most favourable for forging. The temperatures of the minima are at about 900° and 300°. Hence in the process of forging low carbon steels, every precaution must be taken against a fall of temperature to 900°, where the elongation is at a minimum. In the case of medium carbon steels this minimum is inconspicuous, so that the cooling of the specimen is not so critical The investigation of a high speed tool steel containing 18 per cent of tungsten showed that the elongation temperature curve has maxima at 800° and 1100° and a minimum at 950° The maximum at 1100° is very sharp, and hence in high speed tool steels the temperature range favourable to forging is very limited.

ACTIVITY NUMBERS OF HYDROCHLORIC ACID.—The activity coefficients and transport numbers of hydrochloric acid solutions in ethyl alcohol are described in two papers by H. S Harned and M E. Fleysher, published in the Journal of the American Chemical Society for January 1925. The activity coefficient and activity of the acid are about one hundred times greater in alcoholic than in aqueous solutions. The cation transport number, determined by measuring the E.M.F. of the concentration cell $Ag/AgCl/HCl(c_1)/HCl(c_2)/AgCl/Ag$, was found to be 0·654 for 0·1N, and 0·610 for N solutions. These figures are in agreement with the results of Lapworth and Partington (1911). Measurements were also carried out in aqueous alcoholic solutions of the acid.

MICROSCOPE LAMPS.—Several novel and useful types of microscope lamps and illuminating apparatus, suitable for routine work, for micro-projection, and for dark ground and critical illumination, are described in a catalogue recently issued by Messrs. Ogilvy and Co. from their new address at 20 Mortimer Street, London, W.1. Included amongst these is the Hartridge-Williams axial illuminator. This consists of an electric lamp of suitable design enclosed in a ventilated chamber, which can be fitted to any pattern of microscope. The illuminator when fitted forms an integral part of the microscope, occupying the usual place of the mirror. By its use, errors due to polarisation or double reflection from a mirror are avoided and a light source, invariable in position, shape and character, is obtained. No external lamp or bull's eye is required, and adjustments once made are not affected by inclining the microscope or moving it about. The illuminator is fitted with an iris diaphragm which limits the area of light on the specimen to the field of the eyepiece.

Chemistry in India.

DR. M. O. FORSTER, in his address to the twelfth Indian Science Congress, has preached a sermon which is not likely to be forgotten by those who were privileged to hear it or by those who have had an opportunity of reading it. Phrased in the happy manner which came to many as a revelation on the occasion of his address to Section B of the British Association at Edinburgh, it deals with numerous fundamental and intimate questions which are exercising the minds of many thoughtful men and women at the present time. Probably no one can do this kind of thing quite so well as Dr Forster, for he enhances his constitutional optimism by a flow of language which overwhelms the pessimist and carries the reader from the start to the finish along a smooth stream of pleasing rhetoric, past a countryside replete with all that is beautiful and satisfying, only dallying here and there to point out to the traveller some piece of Nature's handiwork more entrancing than the rest, or pausing to express a feeling of admiration for the manner in which scientific man has acquitted himself It is only afterwards that the reader, whose mind, after his journey, will be in a pleasant condition of altruistic confusion, will wonder what it is all about If he is an incorrigible pessimist, and wishes to retain his sanity, he will be well advised to let the first impression stand and not to examine more closely into the nature of the raw material from which Dr. Forster has woven his fascinating fabric. If, like most of us, he is a man of the world without any unhealthy bias towards extreme optimism or extreme pessimism, but, taking things much as he finds them, bestows neither premature praise nor expresses hasty condemnation, he will find much with which he can agree and a great deal to inspire thought and contemplation.

To Dr. Forster's audience the address should be of inestimable value, for India needs scientific stimulation and inspiration far more than any other country of her importance in the world Her immense natural resources and the mental calibre of her races ought to ensure her a foremost place, both scientifically and commercially, among the nations, yet she remains chained and fettered, and probably only one in a million of her inhabitants will be in a position to take to heart the message Dr. Forster sends them Nevertheless, conditions are changing for the better, and the past twenty years have marked a notable advance in the scientific status of the Indian Empire.

The far-sighted vision of an exceptional man led to the founding of the Indian Institute of Science at Bangalore, but it was not until eleven years after the inception of the scheme that all difficulties were removed and the vesting order was signed. Meanwhile, the first director, Dr. M. W. Travers, had been appointed and had drawn up the necessary plans for the organisation and equipment of the new Institute. It is undoubtedly due to the devotion and, indeed, self-sacrifice of Dr. Travers that the scheme assumed definite shape, and that the buildings and laboratories were ready to receive the first students in July 1911. Slight changes in the original organisation were afterwards made, and at the present time there are three chief departments, namely, those of electrical technology, general and organic chemistry, and biochemistry, there is, moreover, a large central building in which the offices and library are housed, the excellence of the latter being due to the organising ability of Mr C. F H Tacchella After the retirement of Dr. Travers in 1914, the post of director was held by Sir Alfred Bourne until 1919 when, after Dr. Alfred Hay had acted as officiating director for two years, the present holder of the office, Dr M O. Forster, was appointed.

It was probably inevitable that, during its earlier years, the Institute should have devoted itself to many *ad hoc* problems arising out of the then existing conditions of Indian manufactures The intention of the founder had been to establish a post-graduate university institution having for its particular object the promotion of advanced study and original research, with special regard to the educational and economic interests of India, but, at that time, advanced education in India was not in a condition to supply a sufficient number of properly trained post-graduate students, and, in those early days, it must have been exceedingly difficult to find the right men to carry out the fundamental research upon which to base the many important industries of the country. Still, in the efficient hands of Dr Sudborough, Dr. Fowler, Dr. Watson, and Dr. Hay, much was done, and the early record of the Institute bears witness to the fact that, despite the obvious difficulties, the research work accomplished supplied material for the improvement of many industries which had hitherto been built on the rule-of-thumb and traditional methods so characteristic of Indian manufacturing procedure as a whole.

The appendix to the fifteenth annual report of the Council of the Institute, dated 1924, is now to hand, and it is evident, from the comprehensive list of investigations which the report shows are being carried out by the three departments already mentioned, that important research work of a fundamental character is being pursued. The lists are indeed pleasing to read and will stimulate Indian graduates to enter the Institute in order to obtain that training in research methods which not only broadens the outlook, but, without which, it is useless for any chemist to hope to achieve real success in industrial work. For knowledge derived from lectures and books cannot supply the vision, the independence of thought, and the honesty of purpose which are essential to the development of the scientific soul, and Indians would do well to learn the lesson some of their confrères in the west find difficult to assimilate, which is embodied in the address given by Dr. Forster at Benares.

JOCELYN THORPE.

Local Natural History in Great Britain.[1]

LOCAL scientific societies have their distinct and special place, with its incumbent responsibilities in the scientific life of the country, and it is well that this important fact should not be overlooked, particularly by the societies themselves. These, it is to be feared, do not always appreciate their obligations to organise and carry through schemes of scientific work which obviously come within their province. Intensive investigations, both systematic and ecological, of the fauna and flora of the country are problems pre-eminently suited to the activities of local societies. In fact, it will be only by the active co-operation and organisation of such societies that

[1] The North Staffordshire Field Club: Transactions and Annual Report, 1923–24.
The South-Eastern Naturalist, being the Proceedings and Transactions of the South-Eastern Union of Scientific Societies for 1924.
The Liverpool Geological Society: Proceedings, vol. 14. Part I., session the sixty-fifth, 1923–24.

it will ultimately be possible to complete our knowledge of these matters.

It is, therefore, with particular pleasure that we direct attention to Mr. L. A. Carr's paper on "The Ichneumonidæ of the Lichfield District, Staffordshire," in the first of the three volumes of annual reports and transactions here noticed, as an admirable example of the kind of work which can and should be attempted by all local societies.

In the course of only eight years' intensive and constant work, Mr. Carr has collected and identified no fewer than 1255 species of this difficult and much neglected group of insects. We do not overlook the work of Mr. Claude Morley and other isolated workers in this field, but obviously the few experts available in Great Britain cannot be expected to cover the whole ground unaided, even if the exigencies of time and expenses for travel could be met. Responsible local workers, like Mr. Carr, are required for all branches of zoology and botany, who, by their own enthusiasm, or aided by the organisation of their local societies, will make themselves responsible for one small part of the field of natural history in the immediate neighbourhood in which they live, and by care, patience, and steady work gradually get together the necessary data from which a true and accurate knowledge of the British flora and fauna can be obtained. Mr. Carr's paper is abundant evidence of the need for such work. No fewer than 335 species in his list are recorded from the British Isles for the first time, and sixteen of the species are new to science. Mr. Carr has had his identifications confirmed and his material examined not only by Mr. Morley but also by Profs. Habermehl and Schmiedeknecht and other leading authorities on the continent. His list is thus authoritative and forms a very valuable contribution to British zoology. Research of this kind is being done widely throughout Great Britain, but we would especially plead for more co-ordination and co-operation in such work by the local societies and urge upon them the example of Mr. Carr's work.

The smaller and less wealthy local societies have received much encouragement and stimulation by their affiliation to form larger bodies, of which the Yorkshire Naturalists' Union is so splendid an example. This and other similar bodies, like the recently formed Union of South-Western Societies, the South-Eastern Union of Scientific Societies, the Lancashire and Cheshire Fauna Committee, and the Faunal Survey of Glamorgan, are attempting to systematise research among affiliated societies and to carry it out on the broad lines suggested above. We should like to see this principle of larger unions extended to embrace the whole country, so that with the local societies affiliated to their proper union, and the unions in turn affiliated to one or other of the scientific societies in London, or, as now, to the British Association, a complete organisation would be brought into being for the thorough co-ordination of the work of local societies.

The unions perform another and perhaps equally important function in bringing the results of scientific research before the general public of the areas they represent, by holding annual congresses at which leading men of science deliver addresses on the special subjects of their own work. The annual volume issued by the South-Eastern Union of Scientific Societies for 1924 gives an account of its annual congress held at Guildford last year, at which Sir Richard Gregory presided and delivered an inspiring address on "Science in Civilisation," in which he sought to revive the belief in the power of science to promote spiritual and material progress and to plead for the fuller recognition of what it has done for the benefit of man. Among the sectional addresses delivered at this congress may be mentioned "Evolution and Eugenics," by Dr. A. F. Tredgold, "The Educational Value of Regional Survey," by Sir F. G. Ogilvie, "Some Remarks on Adaptation," by Dr. A. B. Rendle, and "Modes of Protection in the Pupal Stages of Butterflies and Moths," by Prof. E. B. Poulton.

It is impossible to estimate the value or to overemphasise the importance of the work which the larger unions are doing by this means. A direct link is established between the local societies and scientific workers of the first rank, and the stimulus which the former receive as the result of this contact must largely influence their members and encourage them in the work they are seeking to do.

From the same report we learn of another branch of work which the South-Eastern Union is endeavouring to do, namely, the compilation of a card catalogue of all faunal records for the area, with full notes of all localities. Such bibliographical work is important and useful, and we are glad that the Union, as well as other similar bodies, is alive to the necessity of doing it.

An admirable example of the work done by a local society in one special field is provided by the first part of vol. 14 of the Proceedings of the Liverpool Geological Society here noticed. The seven papers which go to make up this volume include the results of original research by members of the Society, and four of them deal exclusively with aspects of local geology, to the elucidation of which they form a most valuable contribution.

The three publications under notice give ample evidence of the importance and real value of the work of the societies publishing them. They are representative of the work carried on by kindred societies all over Great Britain, and they provide a splendid example to others of the results which can be obtained by organised research, and the scope of the research which local societies can profitably and creditably pursue.

Artificial Incubation.

TWO articles on "The Scientific Principles of Artificial Incubation," by Mr. Llewelyn B. Atkinson, which are of interest to biologists and physicists and of considerable importance to the poultry farmer, have appeared in the Journal of the Royal Society of Arts, November 28 and December 5, 1924.

In Egypt, China and Malay, natural methods of hatching have been replaced successfully by artificial for thousands of years, but among Western peoples the problem of artificial incubation was only solved so late as 1882, when Hearson produced his incubator with a capsule temperature regulator. The Chinese plan is described in "Farmers of Forty Centuries" by Prof. King of the University of Wisconsin, and it is claimed that with this apparently crude method 95 to 98 per cent. of the fertile eggs are hatched. By the Egyptian method described by Capt. Cadman at the Harper Adams Poultry Conference, 1923, 85 to 90 per cent. of the fertile eggs are hatched. Using modern European and American incubators, there is an all-round hatching efficiency not greatly exceeding 55 per cent. of the fertile eggs, though there are plenty of hatches up to 85 to 90 per cent. It is accepted that incubator-hatched chicks compare very unfavourably with those reared by the mother hen, and that the troubles attendant on artificial incubation do not end with the hatching.

Mr. Atkinson sets himself the task of finding why it is

that with far more delicate arrangements than a hen provides, the results obtained by the use of the incubator do not always equal those given by the sitting hen. He concludes that an incubator which will do all that the best hen does and do it regularly and with certainty, is a perfectly realisable instrument. He gives very full details of the physical and biological factors involved in incubation, drawn largely from the results of his own experimentation, and the conditions underneath the sitting hen are compared in detail with those that exist within the various types of standard incubators. The outstanding conclusions at which he arrives are that practically every type of incubator has the air too dry, that the average temperature of the eggs in an incubator is much more regular than in a hen's nest; and that, whereas in modern incubators the whole of the egg is nearly of the same temperature, the temperature of the top being only slightly different from that of the bottom, in the hen's nest the difference between the temperature of the hen's body in contact with the egg and the temperature of the lower surface of the egg is between 14° and 20° F.

From these observations the author concludes that the secret of successful incubation lies in keeping the upper surface of the egg hot and the lower surface relatively cool. This object is attained by covering the upper surface of the eggs with a very thin sheet of india-rubber. The use of this in a hot water incubator, in which the heat reaches the eggs by radiation, is rendered extremely difficult by the fact that the temperature of the tank has to be raised to a most inconvenient degree. In the case of the hot air type of incubator, however, it is quite simple to get a difference of 14° F. between the top and the bottom of the egg by the use of this rubber sheet. It was found also that with this method rapid evaporation of moisture was prevented and that, in fact, the amounts of moisture and carbonic acid around the eggs were nearly those present in a hen's nest. Using this method, an incubator which previously had rarely given more than 55 per cent. hatched more than 95 per cent. of the fertile eggs. It is to be noted that the application of heat to the eggs is by direct contact and conduction instead of by radiation or convection. Every egg becomes its own regulator, controlling the passage of the heat from the upper surface of the egg to the cooler under surface. Mr. Atkinson states also that the chicks emerging from an incubator provided with this rubber sheet are far more viable.

The Blue Whale.

MR. GERRIT S. MILLER'S paper, "Some hitherto unpublished photographs and measurements of the Blue Whale" (Proc. U.S. Nat. Mus., Vol. 66, pp. 1-4, Pls. i.-ix.) is a welcome contribution to the literature of Cetacea. In spite of its predominating importance to modern whalers, the blue whale (*Balænoptera musculus*) is still imperfectly known, particularly with regard to cranial characters. Mr. Miller publishes specially good figures of the skull, the rostrum of which has not suffered from the warping which commonly occurs on drying. He informs us that the specimen (Washington Museum) was an adult male, 75 feet long, captured off Newfoundland in 1903; but it may be remarked that the free condition of the distal epiphyses of the radius and ulna figured in Pl. viii. is evidence that the animal had not completely passed the adolescent stage of Flower, and that in any case 75 feet is a small measurement for a really adult blue whale. The digits shown in the same figure appear to be too straight, and the hand is probably a reconstruction of a disarticulated flipper, as indicated by the fact that the numbers of the phalanges are low as compared with other records.

Mr. Miller makes no comparisons, and his facts must speak for themselves. With regard to the skull, the rostrum deserves special notice, its sides being parallel in its posterior half, then converging in a gentle curve to the tip;—in striking contrast with the triangular, straight-sided rostrum of the fin whale (*B. physalus*). The premaxillæ are noticeably parallel behind, instead of being arched outwards. The postero-internal processes of the maxillæ are long, the orbital plates of the frontals diminish greatly in diameter in passing outwards, and the nasals are stout and broad. The palatines have parallel sides, and in the side view the straight outer edge of the maxilla and the outline of the vertex are other features in which this skull differs from that of a fin whale. Excellent figures are given of the atlas, axis, sternum, pelvic bones and scapula, the last showing the restored cartilaginous parts. As bearing on the great variability of the bones in the larger Cetacea it may be noticed that the sternum differs conspicuously from those figured by True in 1904, as well as from that of the Longniddry whale described by Turner. The long series of measurements of bones will be valuable as material for comparison with southern blue whales, the identity or otherwise of which with the northern species it will be the special object of the *Discovery* expedition to investigate.

S. F. H.

University and Educational Intelligence

BRISTOL.—A research assistantship is open at the Merchant Venturers' Technical College to candidates with an honours degree in engineering. Applications should be made to Prof. A. Robertson at the College.

CAMBRIDGE.—Mr. Arthur Berry has been elected vice-provost of King's College. A new post of assistant director of magnetic research at the Cavendish Laboratory, without stipend from the University, has been established for Dr. P. Kapitza, Trinity College.

By a recent vote of the Senate, the University is to ask the Commissioners to remove from the statutes the paragraph under which certain holders of official positions, such as bishops, heads of house, and privy councillors, can at present be granted degrees *honoris causa* in virtue of the positions that they occupy. University and college teachers and officers are still to be eligible for the degree of Master of Arts, and the University retains its powers to grant honorary degrees to members of the Royal Family, to British subjects who are of conspicuous merit or have done good service to the State or to the University, and to foreigners of distinction.

Dr. Haddon is resigning from the readership in ethnology.

The vice-chancellor, Dr. Fitzpatrick, president of Queen's College, Dr. Giles, master of Emmanuel College; Mr. F. J. M. Stratton, Gonville and Caius College; and Mr. R. E. Priestly, Clare College, have been appointed delegates at the coming conference of the universities of Great Britain and Ireland.

Sir R. H. Biffen, St. Catharine's College, Mr. R. Adie, Trinity College, Mr. F. L. Engledow and Mr. C. W. B. Wright, St. John's College, have been appointed to represent the scientific workers on the Station Committee of the Horticultural Research Station, while Messrs. W. P. Seabrook, A. G. Daniels, and A. T. Paskett represent the fruit and vegetable growers.

Notice has been given that an election will be made next July to the Charles Abercrombie Smith Studentship of 150*l.* a year at Peterhouse. Every candidate must be or must become a research student, proceeding to the degree of Ph.D. The studentship is normally for two years and may be renewed in exceptional circumstances for a third year.

DURHAM.—The seventh Earl Grey memorial lecture will be delivered at Armstrong College on Thursday, March 5, at 7 30, by Dr. F. W. Aston, on "The Structural Units of the Material Universe"

Applications are invited for the professorship in botany at Armstrong College The latest date for the receipt of applications (in each case ten copies) is May 15 They should be sent to the Registrar of the College, Newcastle-upon-Tyne

LONDON —The two following courses of free public lectures at the Royal School of Mines are announced "Chemical Combination in Metallic Alloys and its Nature," by Prof C A Edwards, at 5 30, on March 3, 4, 10, and 11, and "Tubbing Deep Shafts" and "Subsidence," by Prof L Denoël, at 5.15, on March 16, 17, 18, and 19 Free public lectures will be delivered at University College as follows: on March 4, 11, and 18, "Nutrition of the Young Animal," by Prof. T. B. Wood, and on March 9 and 11, "Vital Statistics," by Prof H Westergaard. The lecture hour in each case will be 5 30.

MANCHESTER —Messrs. Brunner, Mond and Co, Ltd, have continued their grants in aid of research in the Departments of Physics and Chemistry.

The Council has adopted regulations for the award of the Philip Buckle Research Scholarship in agricultural zoology This scholarship has been endowed in memory of the late Philip Buckle by his brothers and sisters

Mr J C. Oakden has been appointed assistant lecturer in mechanical engineering in the Faculty of Technology.

THE City of Cardiff Education Committee will shortly appoint a head of the department of physics of the Cardiff Technical College Applicants for the post should send 20 copies of their applications and testimonials on or before Saturday, February 28, to the Principal of the College

APPLICATIONS are invited by the Manchester Municipal College of Technology for the position in the college of lecturer in the chemistry of fermentation processes Particulars of the appointment and a form of application may be obtained from the Registrar The latest date for the return of the completed form is March 14.

THE Commonwealth Fund, 1 East 57th Street, New York, was founded in 1918 by Mrs. Stephen V. Harkness "to do something for the welfare of mankind" and is a philanthropic institution which has already made some noteworthy gifts. It is now announced that twenty fellowships a year in American universities, each of the value of about 600*l.*, have been established for British graduates by the Fund. The fellowships will be tenable for two years, and election will be by a committee of award consisting of Sir Walter Robert Buchanan-Riddell, Bt., Principal of Hertford College, Oxford (chairman), Sir Hugh Kerr Anderson, Master of Gonville and Caius College, Cambridge; Sir James Colquhoun Irvine, Principal of the University of St. Andrews; Sir Theodore Morison, Vice-Chancellor of the University of Durham; and Prof. T. Percy Nunn, Principal of the London Day Training College. The Prince of Wales has consented to become honorary chairman of the committee. The general object of the fellowships is to promote international goodwill and generally to foster unity of thought and purpose in the United States and Great Britain The awards will therefore be made on the basis of character, ability for leadership, health and general fitness, and on the nomination of recognised universities of Great Britain and Ireland.

MR. H SIMPSON GEE, of Knighton Frith, Leicester, who died last July, bequeathed to University College, Leicester, of which he was honorary treasurer, 20,000*l.* free of all duties, to found "The Simpson Gee Endowment Fund" Under the provisions of the will the executors could have deferred payment of the legacy for three years, but they generously offered to discharge the legacy forthwith and give the College the option of taking over certain specified securities of a full trustee character at the "market price" of the day. This offer the College Council gratefully accepted, and as a consequence trustee stocks of this value have been transferred, by which the endowment income of the College has been augmented by 980*l* per annum. Other gifts recently received are:—2000*l* from Sir Jonathan North, chairman of the College Council (by which his donation to the General Endowment Fund has been brought up to 5000*l.*), and 3000*l.* from Messrs Stead and Simpson, Ltd, to the fund for endowing lectureships in chemistry and physics Leicester University College, although brought into existence in 1921 during the post-War economic depression, has, nevertheless, in addition to the finest site in Leicester, on the top of the city, and large and beautiful buildings and college gardens, valued at 150,000*l*, obtained an invested endowment fund which has just completed its first 100,000*l*. In addition, it receives an annual grant from the city of Leicester. By the beginning of next academic year, it will have teachers in all the main subjects of university study, unusually adequate equipment in laboratories, and a library of 9000 volumes

THE annual distribution of prizes was held at the Sir John Cass Technical Institute, Aldgate, London, E.C 3, on Tuesday, February 10, when the prizes and certificates were distributed by Mr S. O. Nevile, past-president of the Institute of Brewing. The chairman of the governing body, the Rev. J F. Marr, in giving a summary of the work of the Institute, stated that although the courses of study at the Institute are principally conducted in the evenings, no fewer than 36 students were successful at the examinations of the University of London during the past session, two of whom obtained the degree of Ph D, and three the degree of M.Sc., by research. In addressing the students, Mr. Nevile stated that institutes such as the Sir John Cass Technical Institute supply two urgent needs of modern industrialism: they offer opportunities for advanced scientific education and training in research, and they enable those engaged in the minor ranks of industry to obtain a knowledge of the principles which underlie their daily work and a broader conception of their industry as a whole. The technology of brewing comprises—first, the production of the raw materials; secondly, the treatment of those raw materials to provide a satisfactory extract; and thirdly, the process of fermentation itself. Pasteur must be regarded as the father of the modern conception of fermentation as applied to the brewing and wine industries. Our knowledge of hops and barley is still very incomplete, and the research scheme of the Institute of Brewing is largely concentrated on these two main fundamental issues.

Early Science at Oxford.

February 22, 1683–4.—A letter from Mr Aston dated Feb. 14 was read, which gave an account of an experiment lately shewn before ye Royal Society by Mr. Paget, viz ye south pole of ye inclinatory needle followed ye flame of a quarter of a sheet of paper, 5 degrees, ye side of ye box being very little hot, ye inclinatory needle was hung in ye plane of ye meridian; ye North pole shunned ye flame.—With regard to a fountain in Poland, that is said to follow ye motion of ye Moon, is cold to ye touch, and yet easily inflammable, Dr Plot informs us, that there is a spring in Lancashire, which, though cold, takes fire, and will harden eggs

Concerning ye Lough-neagh stone, it was ordered, that ye Gentlemen of ye Society of Dublin should be desired, that they would be pleased to impart their thoughts concerning it, ye manner of its being made such, and of what materials it may be made

1686–7.—Mr Halley sent accounts (1) of Mr. Hooke's hypothesis concerning ye changes which seem to have happened in ye surface of ye Earth, from ye shells in beds found petrified in ye Alps, and other hills far from, and above ye sea, and again sea sand and shells, found at great depths underground. (2) Of an experiment of flint and steel in vacuo; which was that there were no sparks visible from ye collision, though they were very vivid in ye same receiver when ye air was admitted (3) Of a very strange effect of lightning from France, viz. that something in it pierced through a piece of glass, making some holes about ye bignesse of pistol bullets, and melting ye edges of ye glass making it smooth like ye edges of a cup. (4) That ye French in Canada have found a whole mountain of lead ore, which lies bare, so that there is no need of mining.

Whereas Mr Hooke thinks that there are not extant any authentic records of ye latitudes of places sufficiently to evince ye fixation of ye Poles, Dr. Bernard observes that ye latitude of Marseilles, taken by Pythias, in ye time of Alexander ye Great, appears to be ye same as 'tis now, and that in ye latter end of Julius Ffirmicus, is an observation of ye latitude of Oxford, taken about a hundred years since.

Mr. Lhwyd communicated ye following curiosities, sent out of ye Isle of Anglesey together with a collection of sea plants and shells:—Eggs of Skate and Dog-fish, *Favus marinus Sibbaldi*, and a broad leaved *Fucus* which had a facing of fine silk in appearance, and was all over garnished with small filaments standing upright, about an eighth of an inch long; much resembling ye stamina of flowers This surface was easily scraped off, and was supposed to adhere to this plant after ye same nature that mosses, lichens, fungi, and such other vegetables adhere to stones, trees, bones, horns, etc.

February 23, 1685–6.—A discourse concerning sounds and echoes, drawn up by Mr. Walker, was by him communicated and read.—Dr. Plot communicated some shells, *Buccina*, in which ye spirals turn to ye left

February 24, 1684–5.—A Horn was communicated by Dr. Plot, said to be a horn, which grew behind ye head of a woman, who was shewn in London about fourteen years since, and is reported to have shed her horn once in three years. This was sent by Mr. Ashmole to be laid up in his Repository.

A letter from Dr. Howman, dated Norwich Jan. 27, gave an account of a hydrophobia in an alderman of Norwich, caused by ye bite of a mad fox. Mr. Walker affirmed, that about fifteen years since a person died mad in Cheshire, having been bitten by a mad cat, which received its madness from ye bite of a mad dog.

Societies and Academies.

LONDON.

Royal Society, February 12.—H. Muir **Evans** A contribution to the anatomy and physiology of the air-bladder and Weberian ossicles in Cyprinidæ In Cyprinidæ the air-bladder is constricted, so as to form an anterior and posterior chamber connected by a short duct. The Weberian mechanism is designed to conduct vibrations and not to register variations of pressure. The nerve-ganglion regulates tension of anterior sac and thus allows it to receive vibrations: it controls the sphincters and prevents undue lowering of tension when the pneumatic duct is open, and excess of tension due to pressure of gas in the posterior sac.—J. S **Huxley** Studies on amphibian metamorphosis II. It is not always possible to induce metamorphosis of the axolotl by enforced air-breathing in a considerable number of specimens This may be due to genetic differences between strains When axolotls are so treated the dorsal fin falls over and fuses completely with the skin of the back By using urethane it was found possible to keep frog tadpoles in narcosis for 8-12 days If previously treated with thyroid, they metamorphosed as rapidly as controls An atmosphere of oxygen is deleterious to tadpoles, and retards metamorphosis A mixture of air and oxygen containing 40 per cent. oxygen allows metamorphosis to proceed at the same rate as in air The dorsal fin of male newts which is developed in the breeding season is not caused to regress by administration of thyroid, unlike the larval fin-crest occupying the same position.—A. S **Parkes** and J. C **Drummond** Effects of vitamin-B deficiency on reproduction In a buck rat on a diet totally deficient in vitamin-B degeneration of testes and sterility ensue The amount of degeneration can be generally correlated both with degree of deficiency and time on the diet The fecundating power of the buck can be definitely correlated with degree of deficiency Size of litter, however, shows little variation. The proportion of males among the young decreases.—A **Dendy** On an orthogenetic series of growth forms in certain tetraxonid sponge-spicules. The so-called streptasters or siliceous spicules of the Theneidæ and Pachastrellidæ are not asters, and the spirally twisted axis which they exhibit is not an elongated centrum They are really derivatives of the primitive triact, which have arisen in accordance with a remarkable law of growth. These spicules, for which the name "dichotriacts" is proposed, appear to form an orthogenetic series of growth-forms, probably representing both a phylogenetic and an ontogenetic series. As in true asters, the increase in the number of rays is accompanied by diminution in size.—C. E. **Walker** The meiotic phase in Triton (*Molge vulgaris*). As is the case in the ordinary somatic mitoses, the univalent filament splits in the telophase of the somatic division immediately preceding the 1st meiotic (heterotype) division. These semivalent threads rejoin in the early prophase; the univalent filaments thus formed join longitudinally, and at the anaphase whole somatic chromosomes are distributed to the daughter cells. The splitting of the univalent filament in the telophase of the last somatic division is not consummated until the 2nd meiotic division, when the chromosomes split into longitudinal halves. The 1st meiotic division is a unique phenomenon interpolated between two mitoses providing for the equal distribution of whole chromosomes.—W. E. **Alkins**: *Clausilia bidentata* (Ström) and *Cl. cravenensis* (Taylor): a statistical inquiry into the relationship of two similar species. *Clausilia bidentata* is widely spread in Britain and elsewhere; *Cl. cravenensis*

occurs only in a restricted area in the north of England, and its specific status has generally been questioned. The altitude, diameter, and diameter/altitude ratio in series of each species collected from limited loci in which both species live together in the same habitat, have been studied While both species, and especially *bidentata*, are highly variable, and though local races may be distinguished within *cravenensis*, the two forms are clearly separated by biometric criteria, and there is no evidence of intermediate forms.

Royal Microscopical Society, December 17.—F. W Rogers **Brambell**: The part played by the Golgi apparatus in secretion and its subsequent reformation in the cells of the oviducal glands of the fowl The Golgi apparatus in the *cells of the alveolar glands* undergoes hypertrophy during periods of activity and reduction during periods of rest. It is not extruded with the secretion The *ciliated epithelium* lining the entire oviduct is also secretory During secretion the nucleus moves down the cell towards the lumen and the Golgi apparatus fragments, and is extruded from the cell The nucleus then moves to the back of the cell and the Golgi apparatus reforms *de novo*. The albumen of the egg of the bird is homologous with the envelope of mucus formed around the egg of the mammal in the Fallopian tube. In this respect the egg of Ornithorhynchus and the marsupials is intermediate The changes in the oviduct of the fowl between the laying of two successive eggs are comparable to the changes in the non-pregnant uterus of the mammal during the œstrous cycle.—R J **Ludford**: Some modifications of the osmic acid methods in cytological technique By treating suitably fixed tissues, after osmication, for 14-21 days with water at 35°-40° C., a good general impregnation of the Golgi apparatus can be obtained Sections can then be stained to demonstrate the mitochondria and nuclear structures Before staining it is desirable to treat sections with 0·1 per cent potassium permanganate, followed by sulphurous acid, in order to bleach the cytoplasm

Geological Society, January 7.—A. K. **Wells**: The geology of the Rhobell Fawr district (Merionethshire) The area described covers some 30 square miles centred about the mountain-mass of Rhobell Fawr The succession ranges from low down in the Lingula flags to the Bala mudstones. A feature of special interest is the development of an igneous cycle at a lower level than anywhere else in North Wales. The centre of eruption of which Rhobell is the denuded basal wreck, was a subaërial volcano which became active during the pre-Arenig interval Basic intrusions are common at several horizons between the Dolgelly beds and the Upper Acid group, and are without exception sills The area provides good illustrations of the action of an intrusive magma in persistently flooding certain horizons and invading selected rocks while leaving others unaffected. As a consequence of its position at the south-eastern "corner" of the Harlech dome, the strike changes almost through a right-angle in passing from south to north. Folding along north-and-south axes is dominant, but the folds have been buckled against the Rhobell mass, which acted as a resistant knot lying in advance of the hard core of the dome. The area is much faulted, the most important dislocations being parallel to those recently described from the Bala district

PARIS

Academy of Sciences, January 12.—A **Lacroix**: The meteorite of Roda. A detailed mineralogical and chemical analysis of this meteorite is given, which only differs from the terrestrial harzburgites by containing a higher proportion of iron.—Charles **Richet**, Eudoxie **Bachrach**, and Henry **Cardot**: The heredity of acquired characters proved by the displacement of the thermal optimum A normal strain of lactic bacillus has a maximum development at a temperature of 36° C. A strain of this bacillus, grown for three years in the presence of potassium chloride, has the optimum temperature raised by 6° C. to 42° C.; and this change persists and is characteristic of this strain of bacillus.—C. **Camichel**, L. **Escande**, and M. **Ricaud**: Overflow weirs.—Paul **Vuillemin**: A normal classification, auxiliary classification, and practical grouping of the fungi.—Bertrand **Gambier**: The invariants of Gauss, Beltrami, and Minding.—A **Kolmogoroff**. The axiomatic definition of the integral.—M. **Lavrentieff**. The sub-classes of the classification of M. Baire.—V **Weniaminoff**: The limit-derivative of an analytical function.—Maurice **Roy**: The adherence of a perfect liquid to a solid which it wets and Lagrange's theorem.—Georges **Patart** The influence of the cooling of a gaseous fluid previous to its compression A demonstration of the advantages of a preliminary cooling of gases before compression.—Emile **Belot**. The movement of a vortex in a resisting medium: application to planetary vortices.—Rafael de **Buen** The influence of the surface temperature on deep thermal changes in the western Mediterranean A discussion of the experimental data given by Richard, Oxner, and Sirvent.—H. **Eyraud** The projective Riemann character of the electromagnetic gravific field.—A. **Perot**. A photographic recorder and oscillograph.—Léon and Eugene **Bloch**: The spark spectrum of tungsten in the Schumann region A catalogue of wave-lengths and intensities of tungsten lines between $\lambda = 1826$ and $\lambda = 1453$.—Charles **Chéneveau**: The formation of optically disturbed media by the penetration of a transparent liquid into a transparent resin.—Jean **Thibaud**. Research on characteristic gamma spectra by crystalline diffraction. The method employed was that of the rotating crystal (velocity less than 1° in 24 hours) and Broglie photographic recorder. The γ spectra were obtained as fine lines without signs of any continuous bands. The crystal diffraction method furnishes a good confirmation of the values attributed to the γ frequencies by the method of excited β spectra.—Fred **Vlès** and Mlle. Madeleine **Gex**: The ultra-violet absorption of petrols. A study of the changes produced in the absorption bands by fractional distillation.—H. **Pélabon**: The direct formation of the mercury oxychlorides. The three oxychlorides, $HgO \cdot 2HgCl_2$, $2HgO \cdot HgCl_2$, $4HgO \cdot HgCl_2$, can be formed directly from HgO and $HgCl_2$ in the presence of water and of alcohol if the temperature is low. The first of these is white and is not formed if the temperature rises above 30° C., but once formed, can be heated to 100° C. without decomposition.—Emile **Luce**: Researches on the migratory aptitudes of the α-naphthyl radicle.— — **Royer**: The rotatory power of cholesterol bodies.—E. **Fournier**: A mode of capture by subterranean erosion, special to certain closed basins of the chain of the Jura.—Ch. **Gorceix**: The metric proof of the ovoid form of the earth. The ovoid proposed as the best representation of all the available geodesic measurements is intermediate between the ellipsoids of Clarke (1880) and **Bessel** (1841).—Jean **Piveteau**: The existence of a reptile with lacertilian affinities in the permian formations of Madagascar. The name *Broomia Madagascariensis* is given to this reptile, which is represented by a large number of well-preserved examples, only the head presenting difficulties.—G. **Mangenot**: The

mode of formation of starch grains in the latex of the Euphorbiaceæ.—Maurice **Lenoir**: The telophase of the first division in the embryonic sac of *Fritillaria imperialis*.—Vittorio **Pettinori**. The toxic action of *Amanita phalloides*. This poison acts not only on vertebrates, but also on infusoria, small crustaceans, the larvæ of insects and fishes. It has no action on the isolated heart of the frog, and probably is without action on lizards and frogs.—Gilbert **Ranson**: The cause of the green coloration appearing on oysters. The pigment of *Navicula ostrearia*, which is unaffected by the digestive juices of the oyster, is shown to be the cause of the green coloration.—Harry **Plotz**: Some observations on the mechanism of serum anaphylaxy. In anaphylaxy produced by serum injection two factors intervene: the physico-chemical state of the serum used for the sensitising injection, and the physico-chemical state of the second injection.—Georges **Bourguignon** and Mlle. Renée **Déjean**: Double chronaxy of the optical system in man.—Jean **Camus** and J. J. **Gournay**: Researches on diabetes and diuresis.

MELBOURNE.

Royal Society of Victoria, November 20.—J. **Ewart**. Stock poisoning in the Northern Territory. Along the main stock route in the Northern Territory very heavy losses of stock have been experienced in recent years and their cause has been in doubt. The cause was determined, by actual experiments carried out in Central Australia on a herd of cattle, to be poisoning due to *Indigofera boviperda*, the indigo cattle bane, and to *Isotropis atropurpurea*, the poison sage. The former is well known as a cattle-killer in Western Australia, but was not previously recorded as killing stock in the Northern Territory. It loses its poisonous properties when dried in a hot sun, owing to the ready decomposition of its alkaloid "cygnin". The Isotropis was not previously recorded as a poisonous plant. It is less poisonous than *Indigofera boviperda*, but the poison is more stable. An extract obtained by Dr. Young is poisonous to guinea-pigs, but the nature of the poison is as yet unknown.—C. **Fenner**: The Bacchus Marsh basin, Victoria. At a period somewhat earlier than middle Tertiary, the whole of Eastern Australia, including Victoria, consisted of low undulating highlands and vast level plains, well wooded and well watered. Under these conditions great brown coal deposits of Victoria, etc., were built up. Later there came some differential uplift of the land, and associated with this there was an outpouring of basaltic lava (the "older basalts"), and about this time the subsidence of Bass Strait possibly commenced. Later, there was another volcanic period (the "newer basalts"); these flows dammed up many of the streams, and filled up some of the old valleys, forming lakes and twin streams and causing a complete change in the drainage system. The faulting which followed or accompanied this volcanic period gave rise to the great mountain system of Eastern Australia. Locally it caused additional alteration in the stream activities. Thenceforward the natural downward cutting, side-swinging, and headward erosion of the Bacchus Marsh streams brought about the formation of the basin as it exists to-day.—A. H. **Coulson**: Geology of the Coimadai area, Victoria, with special reference to the Limestone series. Lower Ordovician and Permo-Carboniferous glacial rocks form the basement of the area, but the paper is concerned with the Kainozoic rocks. These comprise gravels, sands, etc., monchiquite dykes and basalt. The limestone, or more properly dolomite, contains fossils and a very finely laminated mudstone with small grains which bear a strong resemblance to the pollen grains of Pinus. The grains sometimes have a quadrate centre and at others there is a suggestion of spines and wings. The fossils are all referable to the Pleistocene. The extreme uniform fineness of grain and the absence, with one or two possible exceptions, of calcareous organisms, suggest that the dolomitic limestone is the result of deposition of a chemical precipitate of magnesian limestone and differential leaching, in places, giving a more magnesian limestone. Basaltic lava flows followed the sedimentation in the lake, but were preceded by the outburst of a fine ash which has only been found in the limestone lake. The outpouring of basalt completely altered the drainage system of the area. Pyrete and Goodman's Creeks came into existence and deposited, in their initial stages, high level gravels as a capping over the older rocks. In deepening their channels they carried away much of the softer gravels of the old "Bullengarook River," destroyed the limestone lake, and removed most of the limestone, the remnant of which is now covered by the higher gravels of these streams.

Official Publications Received.

Carnegie Institution of Washington. Year Book No. 23, November 1, 1923, to June 30, 1924. With Administrative Reports through December 12, 1924. Pp. xx+433+325. (Washington, D.C.)

Medical Schools of the World. Pp. 2. (New York: The Rockefeller Foundation.)

Commonwealth of Australia. Institute of Science and Industry. Bulletin No. 28. Problems of the Viticultural Industry. By A. V. Lyon. Pp. 84. (Melbourne: H. J. Green.)

University of Oregon Publication. Vol. 2, No. 7, November. A Proposed Classification of Igneous Rocks. By Edwin T. Hodge. Pp. 72. (Eugene: University of Oregon Press.) 1 dollar.

Ministry of Agriculture, Egypt. Technical and Scientific Service. Bulletin No. 47: Cotton Growing in Relation to Climate in Egypt and the Sudan. By C. B. Williams. Pp. ii+81+9 plates. (Cairo: Government Publications Office.) 5 P.T.

The South African Journal of Science. Vol. 21, November. Comprising the Report of the South African Association for the Advancement of Science, 1924, Cape Town. Pp. xl+698+xx. (Johannesburg.) 30s. net.

Hampstead Scientific Society. Report of the Council and Proceedings, with a List of the Members, for the period October 1922 to September 1924. Pp. 70. (London: 32 Willoughby Road, N.W. 3.)

Nyasaland Protectorate. Department of Agriculture. Bulletin No. 1 of 1924. The Destruction of Vegetation and its Relation to Climate, Water Supply and Soil Fertility. Part 1. General Effects of the Destruction of Vegetation, by Dr. F. Dixey. Part 2: The Relation of Forest Vegetation to Climate, Water Supply and Soil Erosion, by J. B. Clements: Part 3. The Erosion of Arable Soil in Nyasaland and Methods of Prevention, by A. J. W. Hornby. Pp. 16. (Zomba.)

Smithsonian Institution: The Smithsonian Institution's Study of Natural Resources. Niagara Falls: its Power Possibilities and Preservation. By Samuel S. Wyer. (Publication 2820.) Pp. vi+28+2 plates. (Washington, D.C.)

Carnegie Institution of Washington. Annual Report of the Director of the Laboratory for Plant Physiology. (Extracted from Year-Book No. 23, for the Year 1924.) Pp. 125-143. (Washington, D.C.)

New South Wales. Department of Mines. Geological Survey. Bulletin No. 7. Gold. By E. J. Kenny. Pp. 60+10 plates. 2s. Bulletin No. 8: Aluminium (Alunite and Bauxite). By L. F. Harper. Pp. 21. 1s. Bulletin No. 11: Cadmium and Mercury, or "Quicksilver." By E. J. Kenny. Pp. 12. 1s. (Sydney: Alfred James Kent.)

Diary of Societies.

SATURDAY, FEBRUARY 21.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—Miss Isabel Burnett: Motives in the Acquisition of Skill.—Prof. T. H. Pear: On Forgetting the Unpleasant; An Examination into Recent Criticisms of Psycho-analysis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (II.).

PHYSIOLOGICAL SOCIETY (at London School of Medicine for Women), at 4.—G. Briscoe: Pressure of Phrenic Effects on Conduction of Respiratory Impulses.—E. E. Hewer and M. F. Lucas-Keene: Histological Preparations of certain Fœtal Tissues (Human).—J. W. Pickering: The Supposed Deficiency of Pro-Thrombin in Hæmophilic Blood.—W. Cramer: The Process of Secretion in the Thyroid Gland.—J. F. Fulton: Plurisegmental Innervation of Single Muscle Fibres (Frog).—A. St. G. Huggett and Prof. J. Mellanby: Preparation and Properties of Secretin.—R. E. Havard and G. A. Ray: The Effect of Exercise on Blood Phosphate.—J. B. S. Haldane: Some Effects of Ingesting $MgCl_2$ and $SrCl_2$.—A. D. Ritchie: Chloroform Rigor in Frog's Muscle.—J. H. Burn and H. Marke: The Relation of the Thyroid Gland to the Action of Insulin.—F. C. Kelly: The Effect of Iodine on the Metabolism

of Nitrogen and Phosphorus in the Growing Pig.—A. D. Kay and W. Smith: The Effect of Insulin on Blood Volume.—H. Florey: Microscopical Observations on the Cerebral Circulation.—D. Woodman: Effects of Parathyroid Feeding.—E. C. Pillman-Williams: Blood Nitrogen Values during Labour.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District) (at Municipal Buildings, Blyth), at 5.—L. Leeper: Five Years' Progress at Blyth.—J. L. Turner. The Law relating to the Collection of House Refuse and Trade Refuse.

MONDAY, FEBRUARY 23.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr. B. N. Peach and Dr. J. Horne: The Scientific Career of Sir Archibald Geikie.

VICTORIA INSTITUTE (at Central Buildings, S.W.), at 4.30.—Prof. A. T. Clay: The Amaru.

INSTITUTE OF ACTUARIES, at 5.—F. L. Collins: Winding up a Life Assurance Company under the Provisions of Section 17 of the Assurance Companies Act, 1909.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. W. De P. Nicholson: The Nature of Tumour Formation (I.).

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. E. Warrilow and others: Discussion on the Electrical Journals, Past, Present, and Future.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (II.) (Cantor Lectures).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—F. N. Doubleday: Report upon Some Drugs and Solutions used in Local Anæsthesia.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Gerald Lenox-Conyngham: The Great Barrier Reef.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir G. Lenthal Cheatle: The Early Stages of Pathological Hyperplasia in the Breast, with special reference to Cysts and their Danger.

TUESDAY, FEBRUARY 24.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15.—Prof. F. E. Hackett and others: Discussion on Modern Theories of Atomic Structure.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—R. H. Brackenbury: Transport in Tropical Africa.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (III.): The Colour of the Chameleon.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 6.—L. H. Savile: The Demolition of the Harbour and Defence Works of Heligoland.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Discussion on Curious Breakdowns.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—T. D. Trees: Selection of Ball and Roller Bearings for Electrical Machines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. C. D. Hickman: Colour and the Psychology of the Kinema.—O. Bloch: A Daylight Viewing and Projecting Filter for Autochrome Plates.—Miss Catharine O. Stevens: A Plea for the Kinematography of Wind Waves.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—R. N. Aveline: The Testing of the Automobile.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—H. H. Blache: The Latest Type of the Burmeister and Wain Diesel Engine.

ROYAL ANTHROPOLOGICAL INSTITUTE (at London School of Economics), at 8.15.—L. H. Dudley Buxton: The Stoney Indians of the Bow River, Alberta.

WEDNESDAY, FEBRUARY 25.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. W. De P. Nicholson: The Nature of Tumour Formation (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. A. H. Cox: (*a*) The Geology of Cader Idris (Merionethshire), (*b*) The Dissection of Pitching Folds.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at *Mining Institute, Newcastle-on-Tyne*), at 7.15.—Prof. T. H. Havelock: The Principle of Interference in Ship-waves and Ship Resistance.

INSTITUTION OF ENGINEERS-IN-CHARGE (at St. Bride Institute, Bride Lane, E.C.), at 7.30.—Discussion on Responsibilities and Difficulties of the Engineer-in-Charge.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—Dr. J. A. Murray: The Making of Microscopical Preparations (I.): Wet Preparations.—F. Summers: Applications of the Microscope in Textile Research.—T. B. Bright. Methods of Examination of Mildewed Cotton Material.

ROYAL SOCIETY OF ARTS, at 8.—Sir Dugald Clerk. The Power of Internal Combustion Engines for Motor Cars.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. N. H. M. Burke: Some Aspects of the Interrelation between Bodily and Mental Disease.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at Liverpool).

THURSDAY, FEBRUARY 26.

ROYAL SOCIETY, at 4.30.—Prof. E. H. Starling and Dr. E. B. Verney: The Secretion of Urine, as studied on the Isolated Kidney.—F. Bickhoist and Prof. E. H. Starling: The Action of Inorganic Salts on the Secretion of the Isolated Kidney.—Dr. G. V. Anrep: A New Method of Crossed Circulation.—Dr. G. V. Anrep and I. de B. Daly: The Output of Adrenaline in Cerebral Anæmia, as studied by means of Crossed Circulation.—Dr. G. V. Anrep and Prof. E. H. Starling: Central and Reflex Regulation of the Circulation.—K. Furusawa: Muscular Exercise, Lactic Acid and the Supply and Utilisation of Oxygen. Part IX. Muscular Activity and Carbohydrate Metabolism in the Normal Individual.—*To be read in title only*:—A. Hunter and J. A. Dauphinee: (*a*) Quantitative Studies concerning the Distribution of Arginase in Fishes and other Animals; (*b*) An Approximative Colorimetric Method for the Determination of Urea with an Application to the Detection and Quantitative Estimation of Arginase.—Dr. J. J. R. Macleod and N. A. McCormick: The Effect on the Blood Sugar of Fish of various Conditions, including Removal of the Principal Islets (Isletectomy).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir Arthur Smith Woodward. Dinosaurs (I.).

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates' Meeting) (at Luton), at 7.30.—W. B. Draper: The Balancing of Automobile Engine Crank Shafts.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir William B. Hardy. Problems presented by Films on Solid Surfaces.

INSTITUTION OF STRUCTURAL ENGINEERS (at 296 Vauxhall Bridge Road), at 8.—E. Godfrey: Reinforced Concrete Columns.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Section).

FRIDAY, FEBRUARY 27.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. J. Manley: Notes concerning the Sprengel Pump.—J. Young. The Thomson Effect in Copper, Iron, and Carbon Steels.—D. W. Dye: Improved Cathode Ray Tube Method for the Harmonic Comparison of Frequencies and for the Delineation of their Wave Form.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. W. De P. Nicholson. The Nature of Tumour Formation (III.).

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—J. Mitchell: Research in Industry.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Practical Problems of Lubrication.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Pickwell: The Monuments and Fountains of London.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—R. Marks: Why Pneumatic Tires?

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. Stroud: A Treatise on Modern Lighting Practice.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.—Prof. A. L. Mellanby and Dr. W. Kerr: Limiting Possibilities of Steam Plant.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (in Cleveland Scientific and Technical Institution), at 7.30.—G. M. Harroway: The Problem of the Workshop.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Dr. B. Malinowski: Mate Selection in Primitive Society.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James C. Irvine: Sugars from the Standpoint of the Organic Chemist.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (I.).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour Browne: My Journey to Brazil.

MONDAY, FEBRUARY 23.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: International Problems of Industry: Problems of the Future.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (Royal School of Mines), at 5.15.—Prof. L. Denoël. Tubbing Deep Shafts and Subsidence. (Succeeding Lectures on February 24, 25, 26.)

BIRKBECK COLLEGE, at 5.30.—Dr. G. G. Coulton: Medieval Education (IV.): The Medieval University.

KING'S COLLEGE, at 5.30.—Prof. W. T. Gordon. The Geological History of Plants (Swiney Lectures). (Succeeding Lectures on February 25, March 2, 4, 9, 11, 16, 18, 23, 25, 30, April 1.)

TUESDAY, FEBRUARY 24.

KING'S COLLEGE, at 5.30.—Prof. W. J. De Burgh: Neo-Platonism and Christianity.

GRESHAM COLLEGE, at 6.—Prof. W. H. Wagstaff: Geometry (Gresham Lectures). (Succeeding Lectures on February 25, 26, 27.)

LEEDS UNIVERSITY, at 8.—Prof. W. Garstang. Animal Life on the Yorkshire Coast.

WEDNESDAY, FEBRUARY 25.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—C. H. C. Baker: The Principles of Design as applied to our Homes.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. R. Cruchet: The Relation of Paralysis Agitans to the Parkinsonian Syndrome of Epidemic Encephalitis.

KING'S COLLEGE, at 5.30.—Dr. Eileen E. Power: Travel and Travellers of the Middle Ages (VII.): The Opening of the Land Routes to Cathay, A.D. 1200–1350.

THURSDAY, FEBRUARY 26.

UNIVERSITY COLLEGE, at 5.—G. A. Sutherland: Auditorium Acoustics. (Succeeding Lectures on March 5, 12.)—At 5.15.—Sir Henry Hadow: The Place of Music in University Education.

KING'S COLLEGE, at 5.30.—Prof. E. W. Scripture: German Poets and their Verse.

SATURDAY, FEBRUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Ancient Mariners of the Pacific.



SATURDAY, FEBRUARY 28, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2887, VOL. 115]

Words, Meanings, and Styles.

II.

THE first element of good style is clearness, and this may or may not be combined with literary elegance. It is usual to regard a split infinitive as a sign of indifference to pure English, yet this misplacement will be found in the works of some of our leading writers. The practice is discussed in an open-minded manner in Tract No. XV. recently published by the Clarendon Press for the Society for Pure English; and though no precise conclusions are reached whether it is permissible or no, the general view taken is that when a split infinitive is the best form of avoiding ambiguity it can be justified It is admitted that the separation of *to* from its infinitive is not in itself desirable, but, on the other hand, obvious artificiality may be introduced when the practice is regarded as a fetish. "To see clearly" is certainly preferable to the split infinitive "To clearly see"; and "To be clearly seen" or "To be seen clearly" to the form "To clearly be seen," but it is difficult sometimes, without splitting the infinitive, to retain the meaning desired. Thus, the pamphlet referred to gives as an example the phrase "we must expect the Commission to at least neglect our interests." To place the words "at least" anywhere else in the sentence would not convey exactly the same idea, and instead of changing their position it would be better to recast the sentence. People who deliberately avoid split infinitives have often an objection to divide a compound verb by adverbs, so that they would write "earnestly may be hoped" instead of "may be earnestly hoped." There is, however, no grammatical reason against such splitting as there is in splitting an infinitive; indeed, the proper place for the adverb is between the auxiliary and the principal verb.

From the point of view of correct grammar, the conjunction "and" ought not to be used to begin a sentence, in spite of its common use in this place in the Authorised Version of the Bible. The function of the word is to add one word or clause to another in a sentence, and this rule is broken when the word opens a new sentence. The incorrect use of "and which" is very common. Generally, either the pronoun or the conjunction should be omitted, or the former is misplaced. When entirely different statements are expressed by two clauses of a sentence, or the cases are different, the relative may be repeated, but not otherwise. Thus it is correct to write, "The results, which support my earlier views, and which I will describe," or "His work on behalf of the scientific world, which he has served so well, and which esteems him so highly," but not "These phrases, which are irritating to read, and which are met every day," or "It is a principle

which is easily understood and which is also easily forgotten." The best way to avoid flagrant errors in regard to the use of "and which," "but which," "and who," and similar combinations, is to omit whatsoever word is intrusive or redundant That is, indeed, the touchstone by which most questions of literary style may be tested

As to particular words and phrases, some of these in common use are indefensible, while the use of others must be left to personal taste to decide It is fatuous to write "to the foot of the letter" instead of "literally," and clumsy to use "it goes without saying" for "it need scarcely be said" or "needless to say" "In the circumstances" is obviously a more correct phrase than "under the circumstances," and "to direct attention" is preferable to the usual form "to call (or draw) attention" "Last," which denotes position, should not be used in the sense of "latest," which signifies time To use the word "phenomenal" to describe remarkable things or events having nothing to do with phenomena is to adopt inept journalese of the same type as the use of the verb "to transpire" in the sense of "to happen" For the use of "over" in the sense of "more than" there is no justification; and "scarcely" is always the correct word to use instead of "hardly" in expressing quantity. "To try an experiment" for "to make an experiment" is, of course, wrong. "After" or "later" is usually preferable to "subsequently"; "total" or "whole" to "aggregate", "viewpoint" or "point of view" to "standpoint", "first" to "firstly"; "person" to "individual" except where a single or separate person is specified; "common" to "mutual", "largely" to "materially"; and there are many other preferences of a like kind.

Purists object strongly to the word "reliable" because of its irregular formation, though the same objection can be made to the words "laughable" and "indispensable." Some authors make the distinction of applying the word "reliable" to things or statements, and "trustworthy" to persons, and that is the general practice followed in these pages. It would be pure pedantry to refer to an engine as "trustworthy" instead of "reliable," and stupidity to describe "reliability tests" as "trustworthiness tests." Mr. B. J Hayes, writing from Burlington House, Cambridge, objects to the use of the word "humanoid" in NATURE of February 7 (p. 201, bottom of column 1), and suggests that "hyperanthropoid" would make the use of the hybrid word unnecessary. His word, however, though correctly formed, would signify that the type referred to as humanoid was in the same direct line of development as anthropoid, whereas it belongs to a separate line.

Most of these distinctions are, however, relatively minor matters from an editorial point of view compared with diversities of paragraphing, punctuation, use of capitals, inaccuracy of quotation, and incorrect references, which come under consideration every day. It is, of course, undesirable to insist upon a uniform style of paragraphing or punctuation; and all that we would urge is that long paragraphs and long periods put too much strain on the powers of attention of the reader. There is little possibility, in scientific articles, of offending in the other direction by over-shortening paragraphs and periods until they reach the staccato style of the sprightly part of the daily press

A quotation may be used as an apt illustration of a particular point, or as a statement of the nature of evidence on one side or the other bearing upon the case upon which judgment is being expressed Of the former class, the authors of "The King's English" describe as trite: balm in Gilead, *e pur si muove*, a consummation devoutly to be wished, the irony of fate, the psychological moment, the pity of it, and many others; and they give the following among common misquotations, the corrections being in brackets: A *poor* thing, but mine own (an ill-favoured), *small* by degrees and beautifully less (fine), *the* last infirmity of noble *minds* (that, mind); make assurance *doubly* sure (double); a goodly apple rotten at the *core* (heart).

We are, however, more concerned with material than with formal quotations, and our experience is that very many writers fail to realise the necessity of reproducing with literal accuracy the extracts they quote, whether for approval or criticism. The number of variations which writers make, deliberately or inadvertently, from the original text is really astonishing to any one who goes to the trouble of verifying what is quoted. It cannot be too strongly insisted upon in a scientific journal that not merely the sense but the actual words and form should be reproduced exactly in a quotation, and that punctilious care should be taken in this respect when the quotation is from a book under review, or from a contribution upon which comments are being made. No wiser advice could be given than that of "verify your references," whether these signify volumes, dates, and pages, or actual quotations.

While an editor can scarcely be held responsible for the accuracy of all the quotations made by his contributors, it is his duty to secure reasonable uniformity in various elements of grammatical and typographical style. For example, certain collective nouns, such as Ministry, Government, Council, Board, Commission, Committee, are used by some writers with a singular verb and by others with a plural. In official practice the plural is commonly used, as "The

Ministry have decided"; here the noun signifies the members of the Ministry and its sense is, therefore, plural. When, however, plurality is not intended, and reference is to a single body, it would seem to be equally correct to use a singular verb. We prefer the verb and the pronoun to be singular, as with a "nation" or "people," where they are always used rightly. On the other hand, nouns like the United States, Physics, and Mathematics, though plural in form are singular in meaning and a singular verb is, therefore, used with them. Here it is not a matter of preference or consistency but of accurate diction.

This brings us to the use of capitals, and there does not seem to be any general rule for capitalisation other than that of the initial letter of the word beginning a sentence Some authors tend towards the German style of writing every noun with an initial capital, but few follow a definite plan, and it is left to editors or printers to secure reasonable uniformity in this respect. Our custom is to use capitals in Latin scientific names of orders, genera, and so on, but not in corresponding English words Thus, we should print Coniferæ, but without the capital letter in conifers, and similarly, Amphibia or amphibians, Crinoidea or crinoids. Every week, however, brings difficulties in the application of any general rule to contributions of different authors, and we have to exercise the editorial prerogative in deciding whether initial capitals should be used or no in such words and terms as Radium-D, Department, Faculty, State, Parliament, Superintendent, Director, Report, Tertiary age and Stone Age, Neolithic Man, Miocene Period and Celtic period, London Clay (or clay), Ångstroms, Theory of Relativity, Quantum Theory, Correspondence Principle, names of elements and minerals, and a host of other examples of a similar kind.

In general, our rule is to use initial capitals only when specific institutions, bodies, divisions, and so on, are referred to, and not when these are described in a generic sense. Thus, we should print, the University of Cambridge, but British universities; the British Scientific Instrument Research Association, but industrial research associations; the House of Commons, but the state legislature; the Middlesex Education Committee, but local education authorities; the State of New York, but the northern states; the Galaxy, but the stellar universe. It may be said, therefore, that initial capitals are used only when they are positively necessary for precise description, and are avoided unless there is an essential reason for them. We realise that our decisions are sometimes purely arbitrary, but in the absence of established principles they cannot be otherwise.

There is only one other matter to which we wish to refer in concluding this discursive article: it is that of the common belief that writers on scientific subjects compare unfavourably with workers in other intellectual fields in the capacity to express themselves in suitable words, or in their appreciation of good English. We cannot accept this view for a moment, and we resent strongly the supercilious attitude which literary people often present towards scientific works. It seems to be taken for granted by some writers who survey published literature from week to week, that no work of science can possibly be classed as literature. We do not hesitate to say, however, that, judged by literary standards alone, scientific books are published every week more worthy of comment than many of those selected to represent the week's literature Though classical scholars and men of letters may not think it derogatory to be without a knowledge of science, most men of science are familiar with one or two languages in addition to their own, and they have, at any rate, a certain acquaintance with the art of literary expression and often the desire to perfect themselves in it The vocabulary of a man of science is probably more extensive than that of a man of letters of equal authority, but it includes many technical words which are understood only by workers in particular fields and cannot be used effectively, therefore, when addressing a wider circle.

That is the chief distinction which need be made between scientific articles and books and those of a purely literary kind It is not necessary for a chemist who is writing for chemists to describe the scientific words and phrases he uses any more than it is for the literary man to explain his allusions, or the historian the significance of his periods and characters. When, however, a chemist is addressing the world of science as a whole, he must avoid the special language of his branch of science if he is to be intelligible, and if he is writing for the general public he has to do so in everyday words and phrases. The standard of suitability of contributions to *Chemistry and Industry* differs, therefore, from that of a general scientific periodical such as NATURE, and this differs again from that of a daily newspaper or of a parish magazine. It ought not, however, to be too much to expect in these days that educated men and women should be acquainted with words and phrases which are part of the common vocabulary of science; and if that desideratum be granted, we may safely claim that the writings of many men of science are truly literary in style as well as scientific in substance, while as regards originality of fact and idea, they are far in advance of all other published works

The Australian Opal.

Opal: the Gem of the Never Never By T. C. Wollaston. Pp. xi+164+15 plates. (London: T. Murby and Co., 1924.) 10*s.* 6*d.* net.

OF precious gems the opal and the pearl take pride of place, for they seem to become part of their wearers, throwing up their beauty and receiving from them additional lustre. Our author has tried both, for he once ran a pearling fleet from Torres Straits to Timor-Laut, but sold out in favour of developing the opal, which seems to him "to be alive and almost as precious as a rose or daffodil." This expresses the motive of the book, the author a naturalist first—a true Wollaston—secondarily, the exploiter of the Australian gem, which he clearly regards as primarily connected with living organisms.

The opal is usually described as an hydrated silica which has consolidated unequally, contracting in different directions. It shows iridescent reflections from surfaces, irregular both in dimensions and arrangement, which by some authorities have been regarded as microscopic pores, arranged parallel (Crookes), while others suppose the inclusion of thin laminæ of foreign substances of different indices of refraction (Behrens), this meaning rich interference phenomena. The amount of water varies up to 13 per cent., and the product fluctuates from a colourless or black glassy substance to the most wonderful play of colours. There has, however, been little recent research on the opal, and these statements as to its structure are based on Hungarian, Mexican, and Honduras stones, which are not necessarily the same in structure as the Australian.

The position would seem to be that there was a sea which in Cretaceous times connected the Gulf of Carpentaria and the Great Australian Bight. It extended over the western halves of Queensland and New South Wales and covered most parts of the Northern Territory and South Australia, ending to the west at an undefined line in Western Australia. Then came the upheaval and the whole was covered with a desert sandstone. This has mostly disappeared by denudation, but its remains are found in a line of low ranges and tablelands down the middle of Queensland and New South Wales, close to the eastern edge of the desert; there is also a big patch, Coberpedy, in the centre of South Australia. These are the bare bones of facts, which the author amusingly clothes throughout his book with an unblushing and charming fantasy.

Everywhere in this desert, sandstone is found showing a tendency to opalisation, but the precious opal occurs principally in its basal part in a thin band or "casing" over underlying clay. Concretionary boulders or nodules of siliceous ironstone are also found containing precious opal, but a usual occurrence in the sandstone is in pipes of about the length and thickness of a pencil; these frequently show colour repetitions along their lengths, more likely, we think, to be metameric repetitions in deposition than due to "unequal pressure." All sorts of cracks and crevices in the sandstone are filled up, and the best colours are frequently shown in small sheets, only 1 to 2 mm. thick.

At the British Empire Exhibition at Wembley the author and others showed an immense variety of specimens. Some were opalised wood, while opals in spaces naturally formed in the decay of wood were also shown. Then there was a great variety of bivalve and coiled shells, some of which appeared to have the shell replaced by opal, but most, perhaps, were rather of the nature of casts. Some specimens, particularly of the blackest opal, on superficial inspection irresistibly suggested sponges and corals. Yet in others, more transparent, transmitted light revealed dark mossy growths, bearing a peculiar resemblance to the boring growths of algæ and sponges in coral, as seen after decalcification. Then there were numerous casts of the small bones and vertebræ of reptiles and of fish, in some cases surrounded by actual bone. Most of the opal had no visible connexion with organic remains, but yet, as our author points out, nearly all Australian opal has a pattern of some sort in it, often in squares or parallel lines; the colour boundaries, too, are generally determinate. Metameric repetition is very usual in the structure of animals, and we saw much in these opals that suggested such structure, but it is hard to suppose that the basal opalised band is directly connected with former organic life. In any case, Mr. Wollaston's account and specimens leave one with the impression that the combined effects of light and structure, from which the opal derives its beauty, are quite probably not the same in the Australian as in the older known opals and demand further investigation, for which the author offers to put material at the disposal of competent researchers.

For the rest, the book contains no systematic and dry-as-dust account of the opal country; there are an extraordinarily interesting series of word pictures, painted with great freshness and vigour. We have rarely read a more vivid diary than that of a visit paid to the opal country in 1888, roughly 1000 miles from Adelaide along the eastern edge of the Great Desert, mostly camel-riding. The journey had all the elements of adventure about it, dangers of direction and of drought, but above all it is a picture of the

"Never-never" land as seen by a real man. Nature is sketched in with a full brush, and the result on the reader's mind is a vivid picture of one of the least known parts of the world, made interesting by a wealth of scientific problems, physical, geological, and biological, crying out for investigation. The many touches of fancy and personality, which make this book so suitable for popular reading, must not be allowed to obscure its value as a distinct contribution to knowledge. J. STANLEY GARDINER.

Endocrine Organs and Secretion.

(1) *The Endocrine Organs: an Introduction to the Study of Internal Secretion.* By Sir E. Sharpey-Schafer. Second edition. Part 1: The Thyroid, the Parathyroids, and the Suprarenal Capsules. Pp. ix + 175. (London: Longmans, Green and Co., 1924.) 15*s.* net.

(2) *An Introduction to the Study of Secretion.* By Prof. Swale Vincent Pp. 168. (London: E. Arnold and Co, 1924) 10*s.* 6*d.* net.

(3) *The Parathyroid Glands in Relation to Disease* By Dr. H. W. C. Vines. Pp. viii + 128. (London. E. Arnold and Co., 1924.) 10*s.* 6*d.* net.

SIR EDWARD SHARPEY-SCHAFER'S well-known book on the endocrine organs, which was founded on a course of lectures (Lane Medical Lectures) delivered at Stanford University in California in 1913, is being rewritten in two volumes, of which the first only (1) has so far been published. This volume deals with the general considerations of internal secretions and the organs which furnish them, and then proceeds to a detailed treatment of the thyroids, parathyroids, and suprarenal capsules. Part 2, which deals with the remaining endocrine organs, will appear later.

Part 1 of the new edition is rather larger than the whole of the first edition, and its greater bulk has been necessitated by a more complete description of the organs and their secretions, and by the addition of many excellent illustrations. The more important literature, and particularly recent literature, is given in footnotes on the pages on which it is referred to in the text. The references are numerous, and while they do not obtrude in any way upon the text, will be found very convenient to any one who wishes to consult the original papers. The literature on endocrinology is enormous, and wide knowledge, personal experience, and a critical judgment are required of any one who attempts to disentangle salient facts from hypothesis. No one is better qualified than the author to undertake such an analysis, for there are few problems in endocrinology of which he has not a first-hand knowledge. The result is a full, authoritative, yet not dogmatic presentation of the subject, which, when completed by the issue of Part 2, will make these volumes the standard work on the endocrine organs.

(2) Prof. Swale Vincent's book is an account of the process of secretion based upon a series of lectures given to medical students at the Middlesex Hospital during 1922–23. Much of it is of necessity elementary, but certain forms of secretion which do not appear in ordinary physiological literature are included, *e.g.* the secretion of gases by the gas bladders of teleostean fishes, hirudin by the leech, silk, the webs of spiders, poisons, the inky secretions of cephalopods, and the luminous substances of light-producing organisms. The anatomical and histological characteristics of the glands are fully described, and most of the illustrations in the book are of histological appearances

Much interesting matter has been collected by the author which has never been brought together before, but is of importance in a general consideration of the subject of secretion. Rather more than half the book deals with external secretion; the remainder is a short summary of the histology and processes of internal secretion.

The author reviews the methods which have been adopted for the investigation of the problems of internal secretion, and has some wholesome criticism to make of modern "organotherapy," a practice which is based upon the assumption that the active substance of the gland is absorbed unaltered into the circulation when administered by mouth. It may be objected that Prof. Swale Vincent is too critical, but in the absence of experimental proof that preparations of the ductless glands, other than thyroid, and, to a much less extent, the active substance of the Islets of Langerhans of the pancreas, have any action when administered orally, his is the only scientific attitude.

In regard to internal secretion generally, Prof. Swale Vincent also sounds a note of caution. It is by no means proved that all the organs classified as endocrine really exert their influence by secreting active substances into the blood, and because this is found to be true of one gland it does not follow that all act in a like manner. The parathyroids are specially mentioned as furnishing an example of a gland which, while it influences metabolism in certain directions, may do so, not by an internal secretion, but by an action comparable to that of the liver cells in their influence upon protein metabolism. One feels that the probability of action by an internal secretion is greater in the case of small glands like the parathyroids, but no harm is done in stressing the fact that much is assumed without proof in regard to the supposed functions of some of the ductless glands.

(3) Dr. Vines has undertaken a difficult task in compiling a monograph upon the parathyroid glands. The difficulty lies in the conflicting views which are held as to their functions At one time the parathyroids were confused with the thyroids, and most of the older literature is permeated with this error More recent views regard the glands as playing some ill-defined rôle in the metabolism of calcium salts, or as concerned with the detoxication of certain nitrogenous bodies, such as guanidine, normally formed in metabolism. Dr. Vines assigns both functions to the parathyroids, and considers they are carried out by different means. He gives an excellent summary of the different views put forward, and references to the more important original papers on the subject His conclusions, however, do not always carry conviction upon the evidence produced

Dr. Vines recognises that the means whereby calcium metabolism is controlled are very obscure and that other ductless glands may be involved. The evidence that the parathyroids are specially involved in calcium metabolism is far from satisfactory. The proofs of their having a detoxicating influence upon guanidine are more certain, and Dr. Vines has elaborated a method of testing this action *in vitro* A table is given showing the considerable variations which he found by this means in the activity of commercial preparations of parathyroid. The possible inactivity of parathyroid preparations is freely discussed, as also is the fact that parathyroid feeding in normal animals has no definite physiological effect. Dr. Vines does not agree with Prof. Swale Vincent that parathyroid therapy is therefore worthless, and gives experimental evidence that parathyroid feeding, even in small doses, has a distinct effect both in diminishing an excess of guanidine in the blood and in promoting an increase of calcium salts in the plasma of the human subject in certain pathological conditions

The difference of opinion is a fundamental one. Dr. Vines claims that a negative effect of parathyroid is to be expected in the normal animal, for in such case guanidine is not present in excess in the blood. Insulin, the active principle of the Islets of Langerhans of the pancreas, has a very potent effect upon the normal animal where there is no excess of glucose in the blood, but the analogy may not be a fair one. Until much more is known about the mode of action of the parathyroid and the nature of its active principle or principles, it is unsafe to express definite opinions. Such criticism is inevitable in the present lack of knowledge about the parathyroids, but is not intended to detract from the value of the work of Dr. Vines, who has rendered a distinct service to medicine in issuing this volume. P. T. H.

A Composite Work on Physical Chemistry.

A Treatise on Physical Chemistry. A Co-operative Effect by a Group of Physical Chemists. Edited by Prof. Hugh S. Taylor. In 2 vols. Vol. 1. Pp. xi+603+41. Vol. 2. Pp. ix+701-1359+41. (London: Macmillan and Co., Ltd., 1924.) 50s. net.

WHILST the group method of writing has in the past been confined almost exclusively to treatises in various branches of medicine and surgery, Prof. Taylor is to be congratulated on a most successful application of the method to physical chemistry. This subject, which unfortunately for Great Britain did not develop with such rapidity as its sister subjects pure chemistry and physics, is now entering a period of a new revival which renders the appearance of this work most opportune It is interesting to note not only a number of British nationality among the seventeen contributors to the various chapters, but also that uniform English spelling is adopted.

The volumes are conveniently so divided in subject matter that the first volume forms the basis for developing the more fundamental laws and properties of matter, whilst in the second a more advanced and in certain portions a somewhat speculative treatment of some of the newer aspects in the development of physical chemistry is presented.

Prof. Taylor has almost achieved the aim of the ideal editor in forming a composite text-book without serious change in either the standard or style of treatment from chapter to chapter The treatment of the gaseous and liquid states of aggregation in the first volume, and of colloid chemistry in the second, might possibly be singled out as somewhat inadequate; whilst the chapters on the solid state of aggregation and electrical conductance in the first volume, on the electro-chemistry of solutions, catalysis and the quantum theory in physical chemistry in the second volume, are really good both in clarity of expression and in the range of material covered.

The text is remarkably free from misprints, of which perhaps the most striking is Helmholz for Helmholtz, whilst Debrouste, p. 133, should surely read Labrouste.

In a book of this character a certain amount of repetition is unavoidable; one might suggest that perhaps a little too much space is given in the first volume to the discussion of Henry's law, which appears both on p. 238 and p. 344, and to the now exploded radiation theory of chemical change in the second.

In discussing dilute solutions in the first volume, the student is led on to the concept of activity and potential functions. If such a treatment were extended to the introduction of the phase rule, p. 367, the reading by

the student of books specially devoted to this subject would be greatly facilitated, whilst the plotting of the temperature as abscissa in the phase diagrams (Figs. 23 and 29) does not seem a very happy innovation.

It is a pity that the erroneous conceptions concerning the determination of the surface tension of solutions by the drop weight method are finding a place in standard text-books. Harkins' extension of Lohnstein's work on this subject might well be replaced by that of Iredale in a future edition.

The important paper of Debye and Hückel on the ionisation of strong electrolytes has been largely utilised in the second volume, and it would form a good substitute for the discussion of the erroneous hypothesis of Ghosh, to which three pages are devoted in Chapter xi. Also, in view of the ever-increasing importance of the amphoteric electrolytes, such as the proteins, a more detailed discussion of some of the electrical properties of such substances would not be out of place. In the chapter on colloid chemistry, Antonov's important rule and the alternative forms of the Gibbs' equation for non-ideal solutions might well have been included

One of the most valuable features of the book is the inclusion of a number of experimental methods, together with a discussion on the probable and possible errors in physical chemical measurements, which serves not only to emphasise the need for consideration of the accuracy of measurements obtained in the laboratory, but also assists the student in visualising the subject both in its theoretical and its practical aspects.

Prof. Taylor, his co-workers, and the publishers are to be heartily congratulated on the production of this text-book, which, at any rate on the desk of the reviewer, will replace all others.

ERIC K RIDEAL.

Our Bookshelf.

Atomtheorie in elementarer Darstellung. Von Prof. Dr. Arthur Haas. Pp. viii + 204 + 2 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1924) 5·40 gold marks.

DR. HAAS is a gifted exponent, with a particular talent for compression. In this book of some two hundred pages he deals with the experimental establishment of the existence of the electron, the quantum theory of spectra, the modern work on X-rays and crystal structure, isotopes, and, in short, all that fascinating body of modern work which centres round the structure of the atom. He touches on such details as the selection principle of Sommerfeld and Landé, with its inner quantum number; the metastable state of the helium atom established by Franck; and the quantum theory of band spectra. There are, of course, only a few words devoted to each of such subjects, but these words are always pertinent and well chosen, and reveal the essence of the results obtained. Bohr's work of the last few years on the grouping of electrons in the general atom, and the interpretation of the periodic table in terms of quanta, is handled at comparative length, the periodicities revealed by the X-ray terms and the bearing of the spectra of potassium and calcium on the electron grouping in the first long period being well explained. The book concludes with an eight-page summary of its contents.

Dr Haas is particularly concerned with the quantum theory of optical spectra, and devotes comparatively little space to the work of Rutherford and his school on scattering and disintegration, and the work of Aston on isotopes, although, of course, this is not to say that these aspects are entirely neglected The general exposition is excellent, although the comprehensiveness of the scheme and the shortness of the book necessarily entail a certain abruptness For a reader already acquainted with some of the fundamental methods and results of the quantum theory, but yet not a specialist in this field, the book offers a very agreeable means of revising his knowledge and extending it in certain directions While the physicist will appreciate the review which the book affords, it is possible that the chemist and the layman, whom the author mentions in his preface, will find the simplicity which the lack of mathematics appears to lend to the book somewhat deceptive. The book has, however, many great merits: it is original in selection and arrangement of matter, concise in expression, includes very recent work, and is written with a knowledge and appreciation which are abundantly evident. E N. DA C. A.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol 28. *Refractory Materials · Fireclays. Analyses and Physical Tests.* By F. R Ennos and Dr Alexander Scott. Pp. iv + 84 (Southampton Ordnance Survey Office, London: E Stanford, Ltd., 1924) 3s. net.

THIS report is intended to supplement volume 19, the well-known report on refractory materials Volume 28 contains notes on the mode of occurrence of fireclays; analyses of about 250 fireclays; and the results of tests on the refractoriness, porosity, tensile strength, and contraction of about 70 clays. The refractory tests for about 50 clays are applied to Ludwig's chart with very fair success To this it may be added that there is generally a difficulty in interpreting the fusion temperature of a fireclay No specification is able to give clear unequivocal instructions as to when a fireclay exhibits "signs of fusion." Discrepant results by different observers show that the "signs" are interpreted differently by different men. This also may explain some difficulties encountered in the general use of Ludwig's chart.

The novelty in the report is the statement that "probably the simplest and most useful chemical method of estimating the refractoriness of fireclays such as those investigated is to determine the combined water." The evidence plotted on p. 72 is far from convincing. From this it would be inferred that a fireclay with between 5½ and 12 per cent. of combined water would have a refractoriness of cone 28; or, taken from another angle, a clay with 5 per cent of combined water might have a refractoriness extending from cone 10 to 26! It will be necessary in the next edition to

show in what way the proposed novelty can be of any use whatever. It is claimed that the "report should prove to be a convenient work of reference in the brick-making and refractory-using industries" This claim will be abundantly justified, the Geological Survey is to be congratulated on the utility of these Special Reports. J. W. MELLOR.

The Pharmacists' Botany. By Dr. George B. Rigg. Pp. xvii+303. (New York: The Macmillan Company, 1924.) 16*s.* net.

MANY of the drugs in common use as medicines are derived from the vegetable kingdom, and are to a great extent supplied to the public by the pharmacist, who has to guarantee their identity and freedom from adulteration. For this reason the pharmacist is required to undergo an adequate training in the science of botany, for which a number of excellent text-books have been published, and institutes exist in which lectures and instruction in practical work are available Indeed, so large is the number of text-books that it is difficult to understand the necessity for an additional one unless it presents the subject in a manner specially adapted for a particular class of students. Prof. Rigg says that his aim has been "to include not only those phases of botany that are of specific use to the pharmacist, but also to give a general view of the subject which will serve as a background for him in his professional work."

A knowledge of the morphology and anatomy of the parts of plants used in medicine is particularly essential to the pharmacist, and in these respects a pharmacists' botany should give fairly complete, accurate, and precise information Prof. Rigg's book does not satisfy this condition; and inaccurate statements occur so frequently as to constitute a serious blemish. The book is well printed, and is illustrated by a number of photographs which, for the most part, answer the purpose for which they are employed. It cannot, however, be recommended for pharmaceutical students or pharmacists until it has been thoroughly revised, erroneous statements corrected, and the details more systematically arranged.

Penrose's Annual: the Process Year Book and Review of the Graphic Arts. Edited by Wm. Gamble. Vol. 27. Pp. xv+142+60+80 plates. (London: Percy Lund, Humphries and Co., Ltd., 1925.) 8*s.* net.

ALTHOUGH, as stated in the review of process work, there has been no outstanding achievement during the past year, the editor has provided a very pleasing and useful volume, as his custom is. The making of half-tone blocks seems to have arrived at a degree of perfection that it is very difficult even if possible to surpass, though the method may perhaps be simplified by the efforts made to render it more systematic. Rotary photogravure is being applied to multicolour printing, and the method is being successfully worked on sheet-fed machines producing excellent work up to speeds of 2500 copies per hour for each colour. A higher output may be expected from the same cylinders when rotary web machines are available. The replacement of the costly solid or tubular copper cylinders used for rotary gravure by iron cylinders faced with thin copper sheets has considerably advanced during the year.

The type used for the letterpress of the volume appears to be a modern reproduction of the Aldine type of the Hypnerotomachia Poliphili issued in 1499, concerning which there is an introductory article. The private press dealt with in an illustrated article is this year the Daniel Press owned by the late Rev. C. H. O. Daniel, of Oxford. Among the very numerous illustrations is a series of examples of posters, mostly in colours, twenty-four reproductions of the celebrated woodcuts of the 'sixties, many examples of offset printing and of colour work, all of which are excellent and of considerable technical interest, and some admirable also because of the beauty of the originals.

A Bibliography of Printed Maori to 1900. By Dr. H. W. Williams. (Dominion Museum Monograph, No. 7.) Pp. xvi+198. (Wellington, N.Z.: W. A. G. Skinner, 1924) n.p.

DR. WILLIAMS' bibliography of printed Maori publications contains nearly 1100 items The mere number, however, does not nearly represent the amount of labour which has been expended in its compilation, as each entry is annotated with information additional to the formal particulars, and in many cases some indication is given of the character of the contents. The author has departed from the strict rule followed by many bibliographers and has included items which he has not personally examined, but as such entries are indicated, those who use the bibliography will in these cases be on their guard. The entries are in chronological order —a disadvantage if the date of the book about which information is sought is not known, or if it is undated —but as the entries are naturally of a very miscellaneous character, ranging from Bibles and prayers to newspapers, dictionaries, and government documents, any satisfactory classification would be a matter of extreme difficulty. Further, the deficiency is to some extent made good by a very full index and a list of authors and translators. In the preface, Dr. Williams reviews previous attempts at Maori bibliography, and his introduction is a valuable account of Maori presses in which the work of the various missionary societies, both in reducing Maori to a written language and in printing it, is fully recognised. The first book to be printed in the language was "The New Zealander's First Book," by Thomas Kendall, the missionary (1815), for the instruction of the natives. It is, Mr. Williams says, scarcely to be recognised as Maori at all.

An Introduction to the Mathematical Analysis of Statistics. By Prof. C. H. Forsyth. Pp. viii+241. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 11*s.* 6*d.* net.

THIS work is intended primarily as a text-book for a course in mathematics and not as a reference book for the statistician. It is to be doubted, however, whether the mathematician as such will be quite satisfied with it. In its scope it is modest, commencing with useful chapters on numerical computation, finite differences, and interpolation, and proceeding by easy stages through probability, averages, a treatment of the normal frequency curve, to correlation. While there are copious and useful examples, the mathematical treatment is patchy and uneven; it is a useful, interesting, but unsatisfying production.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Ages and Masses of the Stars.

SOME of the questions raised by Prof. Lindemann's interesting letter (NATURE, February 14, p. 229) can, I think, be answered at once out of our present store of astronomical knowledge

The sun radiates in round numbers two ergs per second for every gram of its mass, a total of 4×10^{33} ergs a second, of which $1{\cdot}7 \times 10^{24}$ ergs fall on the earth. If the earth had no other source of energy, it would radiate away $1{\cdot}7 \times 10^{24}$ ergs per second from its $5{\cdot}1 \times 10^{18}$ sq cm. of surface, and this would keep the surface at an average temperature of 276° abs. or 3° C This about accords with the facts If the earth's surface is not a perfect radiator the argument is slightly different but the final result is the same If, however, the earth generated energy at the rate of even a thousandth of an erg per second for each gram of its mass, it would have to radiate away $7{\cdot}7 \times 10^{24}$ ergs a second, requiring the quite inadmissible surface-temperature of 131° C. or more in so far as the earth's surface is not a perfect radiator. Even a generation of a 10,000th of an erg per gram per second, requiring a surface-temperature of 29° C or more, would seem to be out of the question

Clearly, then, the mechanism which produces the sun's radiation is absent from our earth, or at best acts very feebly under terrestrial conditions In giant stars, on the other hand, the mechanism is either more abundant or more potent As against the sun's radiation per gram per second of 2 ergs, the bright component of Capella radiates 30 ergs, α Orionis about 200 ergs, *V* Puppis over 300 ergs, and Canopus probably over 1000 ergs.

This leads on to Prof Lindemann's problem as to how the generation of energy per unit mass, E/M, depends on the temperature and density. I think the examples just given suffice to show that E/M is not a function either of the temperature or of the density, which is what ought *a priori* to be expected if the annihilation of matter is the source of energy. The energy transformed into radiation when an electron drops into a nucleus is about 0·003 erg, or a quantum of wave-length $6{\cdot}55 \times 10^{-14}$ cm, corresponding to a temperature of $1{\cdot}5 \times 10^{10}$ degrees. For the production of effects of this intensity, it is scarcely likely to make much difference whether the atomic temperature is 10^6 or 10^7 degrees.

The only satisfactory hypothesis I have been able to frame is that E/M in a star is a function of the state of development of the star. This hypothesis seems to fit all the facts; it would itself be explained if we could suppose matter as originally created to have consisted of a mixture of different types, some of which annihilated themselves rapidly, some only slowly, some perhaps not at all. As matter aged, the more destructible types would disappear, and the whole mass would in time consist only of the less destructible and non-destructible varieties. In a paper read at the January meeting of the Royal Astronomical Society, I showed that this supposition explains the observed facts of the giant-dwarf theory; indeed it seems almost to be demanded by these facts. We have to suppose that only the non-destructible or almost non-destructible varieties of matter are left on our earth, so that there must be kinds of matter in the sun and stars of which we have no knowledge.

The matter of which the earth is formed must, however, be of the same age as that of the sun. Whence, then, the enormous disparity in the two values of E/M? The only answer appears to be that the matter which formed the earth was not a fair sample of the solar substance. On any theory of its origin, the earth must have been formed from the outermost layers of the sun, so that we have to suppose the more destructible parts of the sun's substance to have been confined to its central regions, the heavier elements in the sun must have been more destructible than the light elements which were skimmed off to form the earth.

This leads to a consistent and comparatively simple scheme The heaviest element known on earth is uranium of atomic number 92, but no known reason compels the series of elements to stop abruptly at $N = 92$, and we may quite well suppose that in the sun there were, and still are, additional elements of higher atomic numbers. It is easily calculated that the nuclei of these elements cannot be entirely stripped of electrons, indeed the ionisation potential for the last electron in the uranium atom is about 230,000 volts, corresponding to a temperature of about 17×10^8 degrees (for resonance, 170,000 volts and 13×10^8 degrees) In elements heavier than uranium the quantum orbit $(\infty, 1)$ which approaches nearest to the nucleus comes so near as almost, if not quite, to touch. Even in uranium, as Rosseland has pointed out (NATURE, March 17, 1923), the distance of nearest approach is only $1{\cdot}5 \times 10^{-11}$ cm, which cannot be much greater than the radius of the uranium nucleus (cf. Neuburger, *Ann d Phys*, 70 (1923), p 145) Thus the atomic number 92 may well mark the division between atoms in which the electron orbits are all clear of the nucleus and those in which collisions, or at least very close encounters, between electrons and nucleus are possible The mechanism of annihilation of matter may be found in these collisions or close encounters between electrons and nucleus, in which case atoms of atomic number 92 and less may be immune. It should, however, be noticed that if the rate of annihilation is strictly independent of the temperature, the quantum orbit $(\infty, 1)$ cannot be involved, and annihilation must result from spontaneous drops from orbit 1 to orbit 0, as I originally suggested in NATURE (December 6, 1924) In any case we are free to suppose that matter as originally created consisted of elements of atomic numbers both above and below 92, but that electronic annihilation reduces the number of electrons in the heavier atoms until finally only atoms of atomic number 92 or less are left.

This brings us to a solution of Prof Lindemann's first problem to explain the existence of uranium on earth in view of its comparatively short half-life period of 6×10^9 years. Before the earth was born we imagine the heavier elements in the sun having their atomic numbers lowered by the annihilation of electrons, and emitting radiation in the process. A certain amount of uranium would be created out of the heavier elements by their degradation and probably also, as Prof. Lindemann suggests, a further (and much larger) amount out of the lighter elements by nuclear photosynthesis. The amount of uranium present in the sun would be determined by the condition that the total rate of creation should equal the rate of decay by ordinary radioactivity.

When the earth was formed out of the sun's uppermost layers, the creation of uranium would cease in the earth, for the supply of heavier elements would be cut off, as also the supply of radiation of high enough frequency to produce uranium photosynthetically. The earth's store of uranium would now gradually disappear by ordinary radioactive disintegration. But Prof. Lindemann's upper limit of 6×10^{11} years now appears merely as an upper limit

to the time since the earth was born out of the sun. By a more detailed but similar calculation Prof. H. N. Russell has estimated this upper limit at 3×10^{10} years (Proc Roy Soc., 99 A (1921), p 86).

Our hypotheses doubtless suffer from over-precision, and a more general discussion might permit of a greater age for the earth. It does not seem to me that the presence of uranium and thorium discloses any insoluble difficulties, although it would obviously have been more gratifying if the earth's age had come out a larger fraction of the estimated age of the sun

J. H. JEANS.

February 16.

Robert Browning as an Exponent of Research.

THE comment in NATURE of January 10, p 58, on poets who have touched the field of science may fitly be supplemented by some reference to Robert Browning, whose utterances in this field are often overlooked, although he has shown a deeper insight into the spirit of research than any other poet known to me, and has expressed it many times in glowing words This trait is the more remarkable since Browning evidently knew little and cared little about the particulars of science, and probably found them somewhat repellent, being in this respect widely different from Tennyson, who was well versed in the scientific literature of his day, and used his knowledge of it freely Yet Tennyson's attitude remained always that of the orthodox cultured "naturalist" of Victorian times, skilful in observation, but recoiling in alarm from the outlook to which observation led Browning on the other hand took little heed of the path, but pressed on boldly toward the outlook and gauged the qualities required to reach it. Even in his conception of a poet, as expressed in "How it Strikes a Contemporary," he sees an investigator pure and simple, with an aptitude for understanding and recording vividly pictured in the person of the elderly man of Valladolid, the true "Corregidor" of the city, whose

"—very serviceable suit of black
Was courtly once and conscientious still",

who

"—walked and tapped the pavement with his cane,
Scenting the world, looking it full in face",

everywhere taking such keen "cognisance of men and things" that you might even

"—surprise the ferrel of his stick
Trying the mortar's temper 'tween the chinks
Of some new shop a-building—."

The most frequently quoted though scarcely the most cogent expression by Browning of the spirit of research is contained in that noble threnody "A Grammarian's Funeral," which ought by now to have drawn from some great composer a stately "Searcher's Funeral March" It is unnecessary to recall the many familiar passages—the whole poem is an emotional rendering of delight in the pursuit of knowledge, and pride in its acquisition, whether the apparent gain be great or small.

"He settled *Hoti's* business—let it be!—
Properly based *Oun*—
Gave us the doctrine of the enclitic *De*"

—achievement enough for a Hymn of Triumph

Browning's power in the field of psychology has always been recognised, though his psychology is, of course, tinged deeply with emotion, as in that celebrated and much-discussed example "The Ring and the Book" His grip of the scientific mentality is perhaps nowhere better displayed than in his subtle analysis of the mind of an investigator confronted with a supernormal phenomenon, given under the guise of "An Epistle," from Karshish, the vagrant Arab physician—

"—the picker-up of learning's crumbs,
The not-incurious in God's handiwork,"

to his Sage at home—

"To Abib, all-sagacious in our art,
Breeder in me of what poor skill I boast."

Antique in form but modern in application, the "Epistle" reveals the imagined writer as the possessor of exactly the mental qualities which would do credit to a young travelling medical man of the present day.

This appreciation of research is not, however, noticeable in Browning's earlier poems, one searches vainly for any clear expression of it in "Paracelsus," where one might expect to find it, but it crops up again and again, with increasing intensity, in his later work, and often in unexpected places. Take this, for example, from "Apollo and the Fates":—

"—'Tis Man's to explore
Up and down, inch by inch, with the taper his reason:
No torch, it suffices—held deftly and straight.
Eyes, purblind at first, feel their way in due season,
Accept good with bad, till unseemly debate
Turns concord—."

Or this, again, from "Fust and his Friends":—

"—Man Ignores—thanks to Thee
Who madest him know, but—in knowing—begin
To know still new vastness of knowledge must be
Outside him—to enter, to traverse, in fee
Have and hold! 'Oh, Man's ignorance!' hear the fool whine!
How were it, for better or worse, didst thou grunt
Contented with sapience—the lot of the swine
Who knows he was born for just truffles to hunt?—
Monk's Paradise—'*Semper sint res uti sunt!*'
No, Man's the prerogative—knowledge once gained—
To ignore,—find new knowledge to press for, to swerve
In pursuit of, no, not for a moment attained—
Why, onward through ignorance! Dare and deserve!
As still to its asymptote speedeth the curve,
So approximates Man—Thee, who, reachable not . . ."

Is it not by glowing rhapsody of this kind, rather than by the rendering in verse of specific results in science, be it ever so skilfully and accurately, that the poet can best touch the imagination with a sense of what science is, and may be? G. W. LAMPLUGH.

St. Albans, January 31

The Origin of Sponge-Spicules.

IN the preliminary account by my friend Prof. Dendy (NATURE, February 7, p. 190) it is difficult to see evidence for the independent organic life of his "scleroplastids" There is nothing to prove this hypothesis in the observation that the first rudiment of the spicule in Stelletta is a skeleton-crystal on the tetrahedral system, afterwards overlaid (as we have long known in the tetracrepid desma of Lithistida) with siliceous deposit in amorphous aggregation. Obviously twinning and repetition of branches (also long known) are not arguments against the crystalline character of form in spicules. In 1898 I pointed out certain resemblances to the relations between a symbiotic organism and its host in the relations between a crystal, utilised as a spicule, and the sponge which has secreted it (Proc. Roy. Soc., vol. 64, p. 71). These resemblances seem to have misled Prof. Dendy to his new theory, but he adduces no facts which give evidence for separate organic life in the spicule, or impeach the evidence for its crystalline structure.

I advocated crystallographic explanation of their

symmetry for siliceous as well as for calcareous spicules (*l.c.* p. 70), and the brusque reply then often given that "opal is a colloid" would scarcely now be tendered. Minchin, who at that time followed Schulze in thinking the form of spicules a result merely of the geometry of the canal-system, later accepted the crystallographic theory for calcareous and hexactinellid spicules, though not for those of Demospongiæ (1905, *Zool Anz*; 1908, *Q.J.M.S.*; 1909, *Ergebn. u. Fortschr. Zool.*, ii. pp. 251, 265).

Later work on suberitids, and on the sponge the name of which Prof Dendy has strangely changed to Donatia, has convinced me that the case is as strong for these sponges as for the hexactinellids The Suberitidæ, though included by Prof Dendy in his hospitable group of Tetraxonida, have triaxon spicules; while Donatia shows very interesting evidence of tetraxon crystallisation The conjecture is possible that crystallisation takes place on the tetrahedral system when the spicopal contains 6 per cent of water in chemical union (Siphonidium, Sollas, 1888; Geodia, Butschli (Jannasch) 1901) and on the cubic system when it contains 7 per cent of water (Suberites, Sollas, 1888, Polopogon, Schulze (Moly) 1887), which might be complementary (cf Sollas) to $(SiO_2)_6$ and $(SiO_2)_4$ respectively

I welcome in paragraph (1) [second series of numbers] the word "Mendelian" as showing that our foremost systematist recognises now that the sponges which he investigates are not guaranteed to be thoroughbred Classifiers in general have taken too little account of the *prima facie* promiscuity of the ocean, and for the innumerable "species" of sponges which infest our books "hybridisation must play great part in the characters we laboriously tabulate" (Bidder, Journ. Linn Soc., vol 34, p. 302) If Prof. Dendy will recognise also that the existence and character of spicule-forms can be modified in the individual as the direct physiological consequence of changes in the chemical constituents of sea-water, in temperature, or in light, the nomenclature in his admirable monographs may become simpler

As regards the independent genesis of spicules, the last sentence of Prof. Dendy's letter indicates that he has not observed "scleroplastids" outside cells, and I cannot see that the remainder offers any evidence that they originate outside cells, though I know no reason against silica being deposited in the interstitial jelly of sponges, as lime is in vertebrate cartilage Physiologists have not thought it necessary to suggest that we should recognise as symbiotic bacteria the calcareous granules in the ground-substance of cartilage, or in other tissues the crystals of urate of soda "which are at first gelatinous, but become crystalline" (Noel Paton, Enc Brit., 18, 137) like Prof. Dendy's "scleroplastids."

GEO. P. BIDDER.

Cambridge, February 14.

Instability of Viscous Fluid Motion.

By the courtesy of Mr. C. S. Elton, Dept of Zoology, University Museum, Oxford, the writer has seen photographs taken at Spitsbergen of loose stones on mud flats forming striking patterns of polygons. On inspecting these photographs, Capt. D. Brunt of the Meteorological Office at once recalled a paper by Rayleigh "On Convection Currents in a Horizontal Layer of Fluid" (*Phil. Mag.* 1916). The present writer in turn recalled Bénard's thesis on the same subject (Gauthiers-Villars, Paris 1901).

On referring to these papers, it was found that Rayleigh in fact gives an approximate mathematical theory of Bénard's experimental work, and shows that where a vertical flow of heat produces a temperature and density gradient in a horizontal layer of fluid, an apparently unstable arrangement, with greater density above, acted on by gravity, may actually be stable until the relation is satisfied,

$$\rho_2 - \rho_1/\rho_1 > 27\pi^4\kappa\nu/4gh^3,$$

where ρ, κ, ν, h are the density, conductivity, viscosity and depth.

Multiplying both sides by $gh\rho_1/6$ and dropping the suffix to denote that the mean density may be taken, we get,

$$gh(\rho_2 - \rho_1)/6 > 27\pi^4\kappa\nu\rho/24h^2.$$

The expression on the left-hand side is the energy released by inverting the fluid so that the density gradient downward is the same as the original gradient upward. This expression may be used as an approximation even when the gradient is not linear

When the critical gradient upward is exceeded, instability must appear, at first in a chaotic manner; but certain modes of motion have greater rates of increment characterised by the (real positive) value of q in the factor $\exp(qt)$, and these modes finally prevail over all others.

When the bottom boundary is a solid surface, and the upper boundary a free surface, the chance centres of instability seem always to form on the solid boundary, and to send up threads of fluid vertically which reach the surface and there spread out on all sides until they meet the neighbouring outward flows These meetings determine boundary sheets also vertical or nearly so, down which return flow takes place, the circulation being completed along the bottom

Polygonal prisms are thus formed in each of which circulation takes place The number of sides may be 3, 4, 5, 6, or 7 The triangles are rapidly crushed out of existence, the squares follow more slowly, and if the conditions are kept sufficiently uniform, hexagons finally cover the whole surface with great regularity of form and size

If, however, there is a general flow, v, across the plane, the vertical threads are drawn out into vertical sheets parallel to the v-flow. The return flow also takes place downwards along vertical sheets parallel to the former These sheets divide the layer into long compartments of rectangular cross section

The problem becomes two dimensional, and the motion of instability takes the form of u-w flow in closed paths within the compartments formed by the sheets The most vigorous mode is with the distance between adjacent sheets, one rising, one descending, equal to the depth

When the v-flow comes to rest, cross divisions appear forming squares on the surface, the most vigorous mode for squares being with side $2\sqrt{2}$ times the depth according to the theory, but before there is any sign of this being reached the squares give way to the more vigorous hexagonal mode There is no mathematical solution available for the hexagon, but we may infer from experiment that when the mean diameter is from three to four times the depth, the hexagonal mode is more vigorous than all others.

In applying these results to the stone polygons on mud flats, it may be remarked that the ground, deeply frozen in winter, thaws superficially in summer to a depth varying from a few centimetres upwards. The frozen surface beneath is called the ground ice, and is at 0° C. in the absence of salt water The density of the water will therefore increase upwards with temperature until 4° C. is reached. When we consider the solid matter in suspension, the mixture will have complicated properties in respect of proportion of water, mean effective density, conductivity, specific heat and viscosity, and attempts to form a quantitative estimate of the condition of instability

meet with a formidable array of unknown quantities. According to the theory, however, only a trivial gradient is required for depths exceeding a decimetre to produce instability, and slowly it may be, but in the long run inevitably, the water must circulate, sorting out the lighter materials and conveying them to the polygonal boundaries of the downward flow.

On these assumptions the following predictions were made:

(*a*) That the surface would not depart much from the temperature of maximum water density, 4° C.

(*b*) That in the absence of stones which were merely indicators of the motion, polygonal marks would be formed on the mud.

(*c*) That where the mud flowed down gentle slopes, lines of stones would be formed parallel to the flow, but that where the mud came to rest, cross divisions would appear forming rectangular divisions which would give place later to polygons

(*d*) That the diameters of the polygons would be from three to four times the depth

(*a*), (*b*) and (*c*) were confirmed by Mr Elton, and (*d*) was in accordance with rough observation, the depth being about a metre, the mean diameters about three or four metres

Mr. Elton has since written that according to B. Högbom, from whose paper "Ueber die geologische Bedeutung des Frostes" (*Bull. d geol. Inst Upsala*, vol. xii 1914), the illustration (Fig 1) is reproduced, an explanation based on Bénard's work was put forward by Otto Nordenskiold in "Die Polarwelt und ihre Nachbarlaender" (Leipsig und Berlin, 1910), but was withdrawn in a paper in the "Wiss. Ergebn. d. Schwedische Sudpolarexpedition." 1911. Mr. Elton also gathers from a paper by Huxley that Eakin (U.S.A. Geological Survey Bulletin, No. 631, 1916) has proposed a similar explanation.



FIG 1.—Stone Polygons on Erdmann's Tundra, Icefjord, Spitsbergen.

On applying an arithmetical comparison between Rayleigh's criterion and Bénard's experiments, it appears that instability sets in with less than one-tenth of the gradient required by theory. The fluid used was melted spermaceti, for which the viscosity and conductivity are not known, and for this and other reasons connected with the mounting of the experiments, the comparison is not satisfactory.

Of more general interest is the application of the criterion to the atmosphere. Using the value of $\kappa = 5\nu/2$, given by the kinetic theory of gases and assumed by Rayleigh, the following table of temperature departures from the adiabatic lapse of neutral equilibrium is obtained:

Depth of layer	1 cm.	1 m.	100 m.
Temperature difference in excess of adiabatic	9° C.	9° C. × 10^{-6}	9° C. × 10^{-12}

To account for observed stable layers in the atmosphere with a lapse rate far exceeding the adiabatic for many metres, it is necessary to look for an effective conductivity far exceeding the slow diffusion of the kinetic theory, and this may possibly be found in radiation and absorption, which account for the transfer of heat on an immensely greater scale. Convection of heat is excluded by the assumption of stability.

Even if stability breaks down almost instantaneously, the modes of instability will still be controlled by the considerations discussed above, but further comment must be left to meterologists.

It is remarkable that an analogous criterion may be extended to Prof. G. I Taylor's experiments on the stability of fluid motion between coaxial circular cylinders rotating with given angular velocities ω_1, ω_2. If r is the radius, $\omega r = v$ the velocity perpendicular to radius and axis, then the equilibrium of a perfect fluid rotating steadily about the axis is stable, neutral, or unstable as vr increases, is constant or decreases radially outwards.

If a particular value of vr were an inherent permanent property of each element, the same statement would be true for a viscous fluid. But just as the density gradient in Bénard's experiment is due to the flow of heat, so here the vr gradient is due to the diffusion of v according to the relations for heat transmission, from the faster moving cylinder to the other.

Both the two dimensional case above and Taylor's case come under Rayleigh's extension of Helmholtz's theorem of minimum dissipation, so that the steady dissipation due to the not necessarily small v-motion, and the additional dissipation due to the small u-w motion are independent. Thus we have merely to replace $\kappa\nu$ by ν^2 and the analogy is applicable at once.

Rayleigh has pointed out that with two fixed solid boundaries, the effect of viscosity in increasing the dissipation will be increased In the simple case of laminar motion v across a plane with one free surface, the dissipation is increased four times, for the same mean v, when a second fixed surface takes the place of the free surface.

Taking this as an approximation to the effect in the more complex case of u-w circulation, the criterion becomes .

Energy released by inverting the vr gradient radially $> 27\pi^4\nu^2\rho/6h^2$, *i.e.* four times the previous value.

In this form the boundary line between stability and instability in the ω_1, ω_2 plane is found to be a hyperbola in accordance with Taylor's result, and the diameter is given with an accuracy which is perhaps a trifle fortuitous.

So far this holds only when ω_1, ω_2 have the same sign. When they are of opposite signs, nodes may appear in the u-w circulation, and it becomes necessary to introduce terms of the form $\sin(2\pi z/h)$ as well as of the form $\sin(\pi z/h)$ corresponding to the gravest mode of instability which alone Rayleigh considered.

Enough has been done to allow the analogy between the two-dimensional case worked out by Rayleigh, and Taylor's case to be drawn in full detail.

There are many applications of the criterion which suggest themselves, and seem to make it worth while to bring forward this provisional discussion for wider consideration.

A. R. Low.

The Library, Air Ministry,
London, December 29.

THE experiments of Bénard, and the theoretical discussion by the late Lord Rayleigh, referred to by Major Low, deserve careful consideration from the point of view of their application in meteorology. Rayleigh showed that a layer of fluid can remain

stable, even with the denser fluid above, in virtue of its conduction and viscosity. In the atmosphere it is customary to regard stability as associated with a fall of temperature with height limited by the adiabatic lapse-rate, 1° C per 100 metres for dry air, a greater lapse-rate, or fall of temperature with height, denoting instability. It is, however, an accepted fact that lapse-rates greatly in excess of this value are of frequent occurrence, especially in the lowest 10 or 20 metres, at which height they can be observed at some time of day on almost any day of the year.

An analogy with Rayleigh's result suggests that these large lapse-rates are able to exist only in virtue of the viscosity and conduction of the air When, however, we put figures into Rayleigh's formula, we find that in a layer 10 metres thick, the lapse-rate could not exceed the adiabatic by more than a very minute fraction But Rayleigh's treatment only deals with conduction in the strict sense, the coefficient of conduction for air being derived theoretically from the kinetic theory of gases Now in air the transfer of heat by radiation is enormously greater than by molecular conduction, and for air we should therefore use some higher factor than the ordinary coefficient of conductivity κ in Rayleigh's formula An attempt is being made to derive an expression corresponding to that of Rayleigh for a compressible fluid, taking into account the various factors outlined above.

When we come to discuss the form of circulation which enters when the equilibrium breaks down, we find several examples in meteorology. The cellular form in which the breakdown of the unstable arrangement takes place is most clearly shown in mammato-cumulus clouds. A very fine example of this type of cloud is shown in a photograph by Dr W. J S. Lockyer, reproduced in NATURE for November 17, 1923, p 725 This type of cloud was further discussed by Dr. G. C Simpson in NATURE for January 19, 1924, p 82. Such clouds occur usually in the rear of thunderstorms where there is a general slow settling of air. If there is in this region a layer of cloud or damp air, with a layer of dry air beneath it, then, as pointed out by Dr Simpson, in consequence of the descent the dry air is warmed adiabatically at a higher rate than the damp air, and instability results. The small cloudlets are comparable with the polygonal prismatic compartments of Bénard's experiments.

There is one possible difference, in that in Bénard's experiments the lower boundary of the fluid is a solid surface, and the circulation in each compartment is upward at the centre. In the case of the unstable layer which forms the mammato cloud, the boundaries above and below are interfluid surfaces, and it is possible that the circulation in the individual cell is in the reverse sense to that of Bénard. There is no obvious criterion for determining this. It may be a question of which sense of circulation gives the smaller dissipation of energy. The analogy with Bénard's cells would require that the instability should extend through a layer the depth of which is determined by the physical constants, and is relatively shallow.

It is possible also that some of the phenomena associated with thunderstorms can be explained in the same way. Thunderstorms may be ascribed to vertical instability in the atmosphere, and the violence of thunderstorms would appear to indicate that a high degree of instability is built up before the breakdown occurs. It is suggested that this is brought about by the stabilising effect of transfer of heat and viscosity, up to a critical stage, beyond which the arrangement is unstable, and breaks down with violence. The analogy with Bénard's experiments is borne out by the frequent occurrence of a network of thunderstorms, which break out at the same time over a wide area Further, the ratio of horizontal to the vertical dimensions of thunderstorms is of the order suggested by the analogy with Bénard's cells.

The form in which the instability breaks down near the ground, in the frequent superadiabatic lapse-rates which occur in the bottom layer of the atmosphere, affords an interesting problem, but as this problem is under investigation by others, it can only be referred to in passing Certain details of the records shown by the microbarograph can probably be explained in this manner D BRUNT.

Meteorological Office,
Air Ministry, Kingsway, W C 2.

Blood Pressure in Early Life.

IN a friendly review of my work on "Blood Pressure in Early Life" appearing in NATURE of January 10, criticism is directed to a deduction I made on pp 50-51 regarding the average expenditure of work by the heart in maintaining the circulation at different ages Though this was only one of the sixteen main conclusions, and I admitted it to be the most doubtful of them, I should be glad to have the opportunity of replying to the points which are raised.

I intended to make it clear that my argument regarding the proportionality between cardiac energy expended per minute and the product of pulse pressure and pulse rate was limited to a comparison between *mean values* for large groups of individuals of the same age, that there is any basis for thinking that such a relation necessarily holds good in comparing one individual with another I did not suggest. The initial assumption was that energy expended by the heart was approximately proportional to volume of systole × pulse pressure × pulse rate I then stated (p 50) that "the value of V (volume of systole) cannot be measured readily and it is no doubt variable within certain limits in individuals of the same age, weight, and height, but we may perhaps make two assumptions. (1) that during the period of growth the mean values of V for large groups of growing individuals are directly proportional to the mean body weights of these groups; (2) that the average value of V remains fairly constant in adults up to middle life" From assumption (2) plus the original one it followed that "in comparing large groups of young adults aged 20 and upwards of the same sex, the *mean* product of pulse rate and pulse pressure is directly proportional to the *mean* work done by the heart per minute." This deduction is not merely one of my original assumptions, as the review states, since we have got rid of V from the original equation From assumption (1) plus the original one I further deduced that the "mean expenditure of cardiac energy per minute for a group of individuals of a given age" is proportional to mean weight at that age × mean value of product of pulse pressure and pulse rate for that age. The word "mean" was monotonously repeated and also emphasised by italics because the application of the same reasoning to a comparison between individuals would be unsound, since there is every reason to suppose that V is as variable amongst individuals of a given age as any other anthropometric factor, and probably more variable than most factors.

Without disparaging experiments on the isolated mammalian heart, I should have grave doubts whether the complex conditions met with in the human subject could be reproduced with sufficient certainty to pronounce for or against the truth of any of these

assumptions or deductions Even granting that they could, if the pulse-pressure × pulse-rate product is made to vary in the same heart by artificial means, other factors may come into play, and I know no evidence to suggest that the equation would hold good under any but normal conditions, on the other hand, if only a few different hearts are compared under constant conditions, we are not dealing with mean values but with individuals

The real point at issue is whether the pulse pressure is a factor at all in the actual work done. I cannot agree to the contention that the energy expended "is in no direct manner connected with the pulse pressure" It seems reasonable, however, that the mean pressure should also be taken into account In the somewhat analogous problem of a pump working against gravity, the work done per "beat," ignoring the kinetic factor, is proportional to cross-section of pipe × mean height of fluid × change in level of fluid, and if the fluid level be restored to its original height by a siphon before the next beat, a further multiplication by number of beats per minute gives an expression for energy output per minute Applying the analogy to the circulation, the mean cross-section of the arterial system at ages during growth may be assumed to vary as the mean cross-section of the body, or as the mean square of a linear measurement such as the stature at those ages, and the other factors in the expression are represented by mean blood pressure, pulse pressure, and pulse rate The values of the fourfold product at ages from 10 to 21 (using smoothed figures from the curves and dividing the results throughout by 10^6) are —

10. 4466	13. 6863.	16. 11,264.	19 10,992.
11. 5075.	14. 8155.	17. 11,765.	20. 10,670.
12. 5861.	15. 9927.	18 11,465.	21. 10,490.

This method leads therefore to precisely the same conclusion as before, namely, that "when the age of 16 has been reached the average heart is performing as much or more gross work per minute than in adult life in spite of the fact that it has presumably not attained full size"; the maximum, as before, occurs about 17. PERCY STOCKS.

Dept. of Applied Statistics,
University College,
London, January 26

I REALISE that Dr Stocks, when making his initial assumption that the energy expended by the heart per minute was proportional to the product of the volume of blood expelled at each systole, the number of beats per minute and the pulse pressure, intended this assumption to apply merely to the relationship of the mean values of these factors in large groups of individuals I do not see, however, how this makes the assumption any the more justifiable. The real point at issue is, as Dr Stocks himself mentions in his letter, whether the pulse pressure is a factor in the expression for work done

In the "somewhat analogous problem of a pump working against gravity," the work done per beat is admittedly proportional to the product of the capacity and intensity factors, namely, cross-section of pipe × change in level of fluid and the mean height of the fluid respectively In the case of the heart the pulse pressure, if it is of any significance as an indication of energy expenditure, must be shown to be related to either the capacity or the intensity factor of this energy. There seems to be no justification for including it in the former, especially since the mean output per beat for large groups of growing individuals is assumed to vary directly as the mean body weight. Similarly, to include it in the latter seems equally unjustifiable, seeing that the intensity factor in cardiac work, as was pointed out in the review, is the mean blood pressure during the ejection phase of systole Accurately to determine this mean it would, of course, be necessary to know the average time course and to take the integral of this. This is, however, impossible in man, but the true figure may be approximated to sufficiently accurately if we take in its stead the mean between systolic and diastolic pressures.

If this is done and the product of body weight and mean pressure between the systolic and diastolic levels determined for different age groups, it will be clear that the figures do *not* show any maximum at the age of 16 or 17 years. One may conclude from this that at no period during adolescence is the average heart performing as much work per beat, or taking pulse rate into consideration, per minute, as in adult life. THE REVIEWER.

Diamagnetic Orientation.

GLASER, in a recent paper (*Ann. der Phys.*, 21, 459, 1924), of which a short account was given in NATURE, January 10, p. 64, has shown that the apparent molecular diamagnetic susceptibilities of H_2, N_2 and CO_2 are three times as great at low as at ordinary pressures. He attributes this to orientation, the tendency to orientate being counteracted at higher pressures by the effects of molecular collisions. He is unable, however, to account for the factor 3 in this way.

If the molecules tend to orientate with their axes along the direction of the field, this factor may be easily accounted for. Owing to the relatively large mass of the nuclei, it is only about the line joining them that the molecule will acquire an appreciable magnetic moment under the influence of the field, the effective field being the component of the external field along the direction of this axis. The ratio of the apparent susceptibility for fully orientated molecules to that for molecules orientated at random will then be $1/\int_0^{\pi/2} \cos^2\theta \sin\theta d\theta = 3$.

The importance of extending the measurements to monatomic gases need scarcely be emphasised.

EDMUND C. STONER.

Department of Physics,
The University, Leeds,
January 21.

Animal Mechanism.

WHEN a swan is rushing to the attack of an adversary, the head is lowered and the neck is protended almost horizontally. I had always associated this posture with mere anger, but, during the excessive Thames floods of last December, when swans could often be seen striving against the stream, sometimes, so far as could be judged, in the apathetic state of desperate exhaustion, the same pronation of the neck was frequently evident.

The explanation seems to be dynamical, for the reactions on the feet of the bird would, without the counterpoising action of the neck, tend to rotate the body about a horizontal axis, head backwards. Air resistance also plays a part.

It is of interest to note that the racing motor-cyclist, in his unreasoned but experimentally justified preference for forward weight, has found a solution akin to that of the swan. Many sprinters, especially when starting, use the same principle.

H. S. ROWELL,
Director of Research,
Research Association of British Motor and Allied Manufacturers,
15 Bolton Road, W.4,
February 11.

The Skull and Ancestry of Robert the Bruce.

WE know men better when we have seen them in the flesh, even if we have no speech with them. A knowledge of their homes fills out our mental picture of them. Darwin becomes more alive to us when we have been round his home at Down. There have always been a few who cherish the belief that the skulls of our famous dead, the homes in which their brains lived, and the bony screens on which their living visages were spread, can speak with a precision and with an intimacy beyond even the efforts of the best artist. For the human skull has a language of its own; one which is hard to decipher. After centuries of endeavour we can construe only its simpler hieroglyphics; yet we do continue to improve, and our progress justifies the belief that the day will arrive when a rational craniology will become the handmaid of biography. This is the belief of Prof. Karl Pearson; in a monograph he has published on "the skull of Robert the Bruce, King of Scotland," he has written thus:

"I can imagine a time, when public opinion being sufficiently educated, it shall be looked upon not as a desecration but as a solemn duty, reverently to exhume and study the crania of the departed great with a view of adequately correcting portraiture, or of supplying it where it is deficient." [1]

As all good Scotsmen know, Robert the Bruce was born in 1274 and died in 1329, aged fifty-five. He was buried in Dunfermline Abbey, and there his bones lay until 1819, when they were uncovered during certain rebuilding operations. The traditional and circumstantial evidence leave little if any doubt that the skull and skeleton found were those of the great king. Accurate moulds of the skull were taken before it was reburied; a cast taken from this mould is in the Museum of the Royal College of Surgeons, England, where it is placed cheek by jowl with a King Robert of a later date—Robert Burns. Another and, in Prof. Pearson's estimation, a better cast of Bruce's skull is preserved in the Museum of Edinburgh University, and it is this which he has made the subject of his monograph.

The writer of this notice has also made a study of the cranial cast of the Bruce,[2] and although his methods differ from those employed by Prof. Pearson, yet the main conclusions reached by each are in agreement. The skull of the Bruce has characters of the most outstanding kind, chief of which are the rugged robustness of its face, the outstanding ridges over the eyes, the enormous width across the face from jowl to jowl, and the strength of jaws. He was bull-necked, as is plainly indicated by the extent and strength of the bony platform on the base of the skull whereto the neck is fixed. Such an extensive platform signifies large and strong muscles in the neck, and such muscles in the neck require equally strong muscles of the spine and body. There is in the Museum of the Royal College of Surgeons a rib of King Robert; it is the 9th of the left side. It had been broken in some mischance which had befallen the King, but had healed well and soundly.[3] The rib shows him to have been a big-chested man, one we should expect to have a relatively long body; and yet his thigh and leg bones were not long. Prof. Pearson finds that their dimensions answer to those of a man about 5 ft. 6 in. in height. Bruce may well have been one of those men who seem tall when seated and yet of medium height when standing up, in which case we may add two or three inches to the estimate given by Prof. Pearson.

Bruce's skull is long and particularly wide—its width being about 78 per cent. of its length. His brain was large, Prof. Pearson estimates his cranial capacity to have been 1595 c.c.—about 8 per cent. above that of the average Briton. Neither Prof. Pearson nor the writer attach importance to the size of the brain; what has impressed both are the massiveness and strength of the cranium itself. "Bruce's skull," writes Prof. Pearson, "suggests a man of most exceptional muscularity and strength, with a bull-neck and ardent passions." The writer has expressed his conclusions thus: "It would be the strength and configuration of the face rather than the size of the brain that would weigh with most students if they sought to hazard a guess as to the nature of the man of whom such a skull had formed part. We should suppose him to have been a forceful leader of men." [4] Herein Prof. Pearson and the writer are drawing their inferences not from any systematised body of knowledge but from the everyday observation open to all—that men with such cranial characters as we find in Bruce are swayed by the strong appetites and passions of the natural man. If tradition speaks true, Bruce was no exception to this widely held belief.

Of what race was Bruce? Prof Pearson, following tradition, looks upon him as a hybrid between Norseman and Celt, and adds: "He was able by Celtic imagination, with a certain dash of slimness, to win the Scottish nation to his side, and by aid of Nordic physique and persistency to be triumphant over his enemies" This statement might well be a quotation from the speech of a political historian; it certainly is not the language of craniology. The term Celt has been applied to diverse breeds of men, but Bruce's cranial type is not prevalent in any of them. Nor is it a type which is found in Saxon or Danish graveyards, although samples do occur in the Frankish burials of the north and west of France. Bruce's skull has more in common with what has been named by British anthropologists in recent years the "beaker" type than with any other known to the writer. Men with this type of skull began to take up their habitation along the eastern coasts of Britain early in the second millennium B.C. They are known as "beaker" men because of the peculiar kind of earthenware vessel buried with them. Before they appeared in Britain they had penetrated to Baltic lands and spread southwards into France. Bruce's ancestry may have acquired the "beaker" blood in Baltic lands, in France or in Cleveland, where the type still persists.[5]

It is this persistence of type which lends interest to the comparison of ancient and modern skulls. Those familiar with the skulls of beaker men obtained from

[1] *Biometrika*, December 1924, vol. xvi., Pts. III.-IV., p. 260.
[2] Phrenological Studies of the Skull and Brain cast of Sir Thomas Browne of Norwich, Henderson Trust Lectures, No. III. Edinburgh, 1924.
[3] This rib was taken from the open tomb in 1819 by Dr. William Mackenzie, whose life appears in the "Dictionary of National Biography." He died in 1868. He was both accurate and learned, and was regarded in his day as the leading ophthalmic surgeon in Scotland.
[4] *Loc. cit.*
[5] The spread of the "beaker" type has been discussed in an address given by the writer on "The Bronze-Age Invaders of Britain," Journ. Roy. Anthrop. Institut., 1925, vol. 45, p. 12.

the round barrows of Wilts have no difficulty in recognising their counterparts among their companions of to-day. After a hundred matings or more in a land where long heads have vastly outnumbered the round heads, this beaker type still persists. Darwin was almost a representative "beaker" man, wherever leading British men are met together there is certain to be an undue proportion of round-heads In more senses than one the beaker type is dominant.

The first article[6] in the number of *Biometrika* which contains Prof. Pearson's study of the Bruce's skull, helps us to understand such a persistance of a human type. This article by Dr. Ernest Warren deals not with human beings but with foxgloves, but we can legitimately transfer his results from the one to the other, for we have every reason to believe that heredity works in the human stirp just as it does on that of the foxglove Dr. Warren observed that parental characters may form a perfect blend in the progeny, or there may be no blending—the characters of one parent dominating or ousting the corresponding character of the other parent To use his own words: "Mendelian inheritance and perfect blending inheritance may be regarded as the two end terms of a series, and all grades of partial blending or partial segregation lie between." The same must be true of human matings, at least such a supposition accounts for the facts which are brought daily to the notice of anthropologists The man of the Magdalenian period, unearthed recently near Bonn, had just such a development of cheek and jaw as reappeared in Robert Bruce some ten or eleven thousand years later.

In his search for authentic portraiture of the Scottish king, Prof Pearson consulted the image on the Scottish coins of Bruce's reign He found that the stamped image was in no sense a portrait. "As for the eye," writes Prof Pearson, "it is remote from the orbit, but this is an artistic (?) convention even in the case of modern designers' profile portraits. On a penny postage stamp or a half-crown of his present Majesty the King, the distance from nasion to outer border of orbit is about one-third of the distance from the nasion to auricular passage, whereas in the profile of a skull it is nearer one-fifth" Herein Prof Pearson does the designer of His Majesty's image a certain degree of injustice. The extent to which the nasion (or root of the nose) projects in front of the side wall of the orbit, when a skull is viewed in true profile, is a guide to race, and hence the writer has given this facial character some attention. In Bruce's skull the nasion lies 97 mm in advance of the mid-point of the ear passages; the sides of his orbits 72 mm.; the difference between these measurements—the *naso-orbital depth*—is 25 mm., this being 25·8 per cent. or rather more than a fourth of the auriculo-nasal projection.

Herein King Robert was typically British, for in ten male British skulls taken at random, the mean of the corresponding measurements were 95·8 mm. and 71·2 mm.—the naso-orbital depth being 24·6 mm.—or 25·7 per cent. of the naso-auricular line. To obtain a face in which the naso-orbital depth falls to Prof. Pearson's standard, a fifth or 20 per cent., one has to go to skulls of Chinamen. Ten male skulls of this race, taken at random, gave these measurements, 92·8 mm. and 74·4 mm.—the naso-orbital depth being 18·4 mm.—almost exactly one-fifth of the naso-auricular projection. In the image on the half-crown which lies before the writer, the nasion is 8 mm. distant from the ear passage and the margin of the orbit 5 mm. The naso-orbital depth given by the designer of the coin is 38·5 per cent. of the naso-auricular distance—certainly 12 per cent. more than it should be were His Majesty's head represented in true profile But then it is not a true profile; the artist has purposely turned the head far enough towards him to make the opposite (right) eye-brow visible, and his drawing gives His Majesty's features in their just position It is otherwise with the photographs which Prof. Pearson has reproduced of the Bruce's skull; the camera, as cameras always do, has given a distorted view of the skull, reducing Bruce's naso-orbital distance to one-fifth of the naso-auricular line, thereby committing an error of nearly 6 per cent The photograph of a skull cannot take the place of an accurate drawing; in the writer's opinion, photographs are useless as craniological documents

It is a curious circumstance that although Scotland has produced an undue share of anatomists, she has had to depend, until lately, on Englishmen for a knowledge of her own people It was Dr John Beddoe who made the first anthropological survey of Scotland; it was Sir William Turner who first made a study of the craniology of its inhabitants past and present Now Prof. Pearson has given the first adequate account of the skull of their great king To those who have studied Prof Pearson's monograph it must seem particularly ungracious on the part of a Scotsman to allow such carping criticism as he has just made above to escape from his pen, for in his final paragraph Prof. Pearson makes an appeal which must dissipate the "Scots-wha-hae-ism" of the most stony-hearted native of North Britain. There the great biometrician writes thus "Even the aged dream dreams, and I should like to see a national monument to Bruce at Westminster, an effigy based on the skull as only a great sculptor could conceive it But it should be the gift of Englishmen only to the united nations. . . . The union of our nations needs no artificial cement, but it would be a graceful act for Englishmen to present Scotsmen with what at present they lack, a real characterisation—which I hold is still feasible—of one of their great heroes"

Far be it from the writer to damp in the slightest degree so gracious a proposal, and yet there may be some who will think that Prof. Pearson, while he gives with one hand, does take somewhat away with the other. He suspects that Robert Bruce may have been the subject of syphilis—a suspicion which never crossed the minds of the very able medical men who examined the king's skull and bones when they were disinterred. The writer has searched the pre-medieval graves of England and Scotland for traces of syphilis and found none, and those who know our medical records believe that Robert Bruce had been asleep in Dunfermline Abbey for two centuries before this fell disease appeared in Britain.

A. KEITH.

[6] "On an Interspecific Hybrid of Digitalis," by Dr Ernest Warren.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

9. GEORGE GABRIEL STOKES (1819–1903).

THE collection of Sir George Stokes's published papers, together with the "Memoirs" and scientific correspondence edited by Sir Joseph Larmor, contain such an excellent account of Stokes's activities and personality that nothing remains but to confirm, illustrate, or emphasise what is already on record

Stokes was elected as one of the secretaries of the Royal Society six years after the constitution of the Society had been altered by the limitation of the number of fellows elected annually. It was a critical time, and though there was no sudden change in the policy of the Society, new traditions had to be established The range of his knowledge, the width of his sympathies, and his almost infallible judgment peculiarly fitted Stokes for a position which offered so many opportunities of advising striving and sometimes stumbling men, and guiding their work into profitable directions

My own experience was similar to that of many others. In the account I gave of Osborne Reynolds, I mentioned a certain experiment which I had performed demonstrating that the motion of the radiometer was due to internal stresses. The paper describing the experiment was sent to the Royal Society and I received, in due course, a communication from Stokes forwarding some suggestions made by the referee I complied to the best of my ability, and in informing me that the paper had been ordered to be printed, Stokes added, that in his judgment the paper was not improved by the changes I had made in deference to the referee. He further made a significant remark, which is worth remembering by those charged with the difficult and responsible task of reporting on papers. It was to the effect that, in his opinion, it was best to allow the authors of papers to express what they had to say in their own words, even when improvements might be effected When I quoted this remark to Maxwell a year or two later he told me that he had been the referee, but I believe he agreed with the general principle. The suggestions which Stokes himself so frequently made to the authors dealt with matters of principle rather than with the manner of expression.

I have in my possession five letters written by Stokes during March and April 1885, and dealing with a subject on which there has been, and still is, a good deal of misapprehension The question at issue is referred to in the correspondence of July and August 1899, reprinted in the "Memoirs," vol. ii. pp. 123-125.

Stokes writes to Rayleigh in July 1899:

> "Some years ago Thomson or Kelvin (I forget which he was then), you, and I were together at the Royal Society, and Kelvin asked me what I thought of a result you had arrived at that the appearance of bands of interference in a spectrum did not prove regularity in the light, but only high definition in the spectroscope. If this meant what it appeared to mean I utterly disbelieved it, it seemed so manifestly untrue."

In his reply Rayleigh writes:

> "I am afraid that I shall stand condemned, for I do think that 'a vast succession of independent impulses following one another casually' would show interference, of course with the aid of a spectroscope."

My correspondence with Stokes, which took place fourteen years earlier, deals with a design for an experimental arrangement suggested by him, which it was hoped would give "a large retardation of one of two interfering streams of light relatively to the other, and yet having the bands in one part of the spectrum so broad as to be easily observed, unless that should be prevented by the irregularity of the vibrations of the incident light."

The method depended on introducing into one of the interfering streams of light a dispersive medium, having a length adjusted so as to make the difference in path measured in wave-lengths in the two streams equal to each other within a certain range of the spectrum, in a manner suggested by that adopted in achromatising lenses I do not now remember what ultimately prevented the investigation from being carried out. When I examined the question some years later (*Phil. Mag.*, June 1894) in the light of Gouy's and Rayleigh's discussion of the subject, I was fully converted to their opinion, but I do not believe that Stokes was ever convinced In my judgment, the effect anticipated by Stokes in his arrangement would have been observed with sufficiently great resolving power, but it would have taught us nothing on the regularity of the incident light, because the observed regularity would have been introduced by the resolving power

During my stay at Cambridge, many tales were current with regard to Stokes's taciturnity My own experience is in the other direction. On several occasions I sat next to him at College dinners, but never had any difficulty in finding a subject of conversation on which he would enter with pleasure and sometimes with animation He had several interesting tales of his intercourse with Brewster, who never could be made to abandon the corpuscular theory of light. Even when Foucault had proved that light was transmitted more slowly through water than through air, Brewster refused to give in.

Stokes was an old man when he died, but his scientific outlook always remained young. New ideas pleased him, and he delighted in hearing of experiments that did not fit in with any of the accepted theories His peculiar form of wit is referred to in the "Memoirs," and I recollect one instance of it. At an excursion, during the celebration of the Kelvin Jubilee at Glasgow, Rontgen's discovery of the X-rays was referred to in the presence of some of the foreign delegates Quincke stood up for the claims of Lenard, whose work according to him had to some extent anticipated Rontgen. Stokes replied: "Lenard may have had the rays in his brain but Röntgen got them into other people's bones." Whenever I afterwards met Quincke he never failed to repeat this remark with enjoyment.

The strong religious opinions held by Stokes are well known. I am told, on trustworthy authority, that he voted against the extension of university privileges to

[1] Continued from p. 271.

non-conformists, but this should not be taken as an indication of any want of religious tolerance. His whole life would contradict such interpretation. He could only have acted under a strong sense of personal responsibility.

In the sketch of her father's life, Mrs. Humphrey writes (vol. i. p. 6): "As a little boy he was subject to violent though transient fits of rage . . ." I was interested in this remark, but not altogether surprised, because I once saw an almost ferocious look on Stokes's face. It was at a meeting of the British Association when he thought that some one was taking a liberty with him. But this look was quickly replaced by his usual smile, as he turned round and saw that it was only Lord Kelvin patting him on the back.

Stokes lived a long and useful life, alert and vigorous almost to the end. There are few men who have secured the esteem and love of their fellow workers to the same extent. I shall always remember Lord Kelvin, as he stood at the open grave, almost overcome by his emotion, saying in a low voice: "Stokes is gone and I shall never return to Cambridge again."

The Vision of Nocturnal Animals.

By Prof. S. Russ.

IN some experiments, conducted with Dr. J. C. Mottram during the War, upon the best conditions for night vision, the question arose as to what part the transparency of the media of the eye plays in determining acuity of vision in dim lights. It is known that individuals vary between wide limits in their night vision, some appearing almost blind in a night of average darkness Further, it is known that many wild animals have very little difficulty in making their way about or in finding their prey in dim lights, though the sense of smell may not, in the latter category, be neglected. In the night owls this sense is, I understand, excluded, for they find their prey solely by the sense of sight.

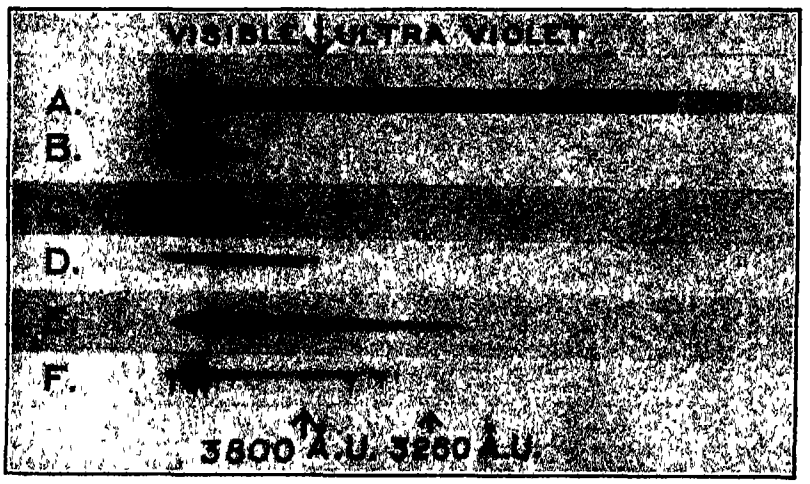


FIG. 1

Experiments of a direct character were made upon the enucleated eye by cutting away a small portion of the retina at the back of the eye and cementing over this aperture a thin quartz plate. It was generally possible to do this without loss of fluid or deformation of the eye; this was now mounted in front of the slit of a quartz spectrometer, and the extent to which the radiation from an arc (cadmium or tungsten) was transmitted through the eye was measured photographically. It was soon evident that all of the eyes tested exerted, as was expected, a considerable degree of absorption for the major portion of ultra-violet radiation from the arc, but that what appear to be significant differences were shown by the eyes of different animals.

In Fig. 1 are collected the results of a number of such experiments: The strip A is a photograph of the ordinary arc spectrum of cadmium; the remaining photographs are with the experimentally mounted eyes interposed between the arc and the slit of the spectrometer. B shows the transmission by a human eye; and the other strips transmission by eyes of a lioness, C; a bear, D, great eagle owl, E; and a tiger, F. Others tested were the eye of an ox, which showed about the same degree of absorption as the human eye, and a cat, which closely resembled that of the tiger. Three human eyes were tested, and they showed no important differences from one another. How far the different degrees of transparency shown are dependent upon post-mortem changes, it is scarcely possible to say; it may be mentioned, however, that the human specimens were probably fresher than any of the others, yet they showed the greatest opacity to the short wave-lengths.

On testing in the same way the various parts of the eye, it was found that the lens was a more absorptive element than the cornea, the humors of the eye being more transparent. It is interesting to note that, if a person is examined in pure ultra-violet radiation, the lens is seen to fluoresce vividly, the cornea less so. The sensation when one is subject to this invisible radiation is that of the eye being filled with a pale blue light.

At a meeting of the Ophthalmological Section of the Royal Society of Medicine on January 9, these observations were discussed in their relation to night vision. If it be a fact that the eye of the nocturnal animal or bird is transparent to a certain range of ultra-violet radiation, and that this reaches the retina in an appreciable quantity, it may be that it is a valuable aid to vision. In the discussion, Sir John Parsons questioned the value of such a radiation to an eye chromatically adjusted to the visible region, but little is known about the range of radiation for which the optical parts of these eyes are most efficiently adapted. Prof. Hobday mentioned that, during the War, Australian horses were used in Palestine for night work, because they did not suffer from night-blindness.

Obituary.

DR. HORACE T. BROWN, F.R.S.

A PENALTY of living is to outlast one's friends, especially the oldest, earliest and most esteemed. Not long ago, I engaged in the impossible task of painting a picture of James Dewar, whom I first met in 1875. Now, the call comes for a portrait of Horace Brown, my fellow-student in 1865, the last of the great Burtonian chemical quartette—Peter Griess, Cornelius O'Sullivan and the brothers Brown. My palette must be cleaned and charged anew with very different colours—the lights and shades to be depicted are of another order. No two persons stand in greater contrast. The one a man of fire and fury, a volcano of surging impetuosity, astounding in his individuality—the other, one of Nature's gentlest men, though adamant in purpose, gifted with a placid personality and a refined urbanity and charm of manner which won for him a large circle of devoted friends, scarce a detractor. Both were philosophers but the one was a consummate artist and actor, the other a naturalist from birth and, though not born to blush unseen, sparing in criticism, reticent and retiring, a conformist in most matters.

Horace Brown was congenitally fitted to walk the paths of chemistry on vital territory. Few are, strange to say: the mentality of most chemists being definitely mechanical and physical; only the elect seem to be able to sit quietly on "the dear old Nurse's knee." He was pre-eminently happy when wandering in her company, whether in the open field or in the laboratory—unveiling the activities of micro-organisms and separating the sheep from the goats, wet-nursing the barley-embryo or tracking the nimble molecules of carbon dioxide, through the stomatal openings, on their way to destruction and burial as sugar and starch in the vegetable cell. The secret of his success lay, I think, in his great powers of application and concentration and the faculty he had of getting up the subject he wished to explore, by prolonged preparatory study.

I have told the story of the family in my notice of Adrian Brown, his half-brother. He was a posthumous child, born July 20, 1848. His father began life as a farmer, so he came from the soil, as he once said to me. His mother's remarriage, to Edwin Brown, brought him under the care of a man of high attainments and wide culture, an ardent naturalist—so he grew up under most favourable conditions. His scientific leanings were such that he began to study the stars seriously in his out-of-school hours when only twelve years old. A year or so later, electricity caught his fancy. Following a book which he found in his stepfather's library, he made a frictional machine and a Leyden jar, which gave him great joy; he even went so far, that he constructed a galvanic battery, with which he studied electrotyping. The fortunate gift of a microscope, when he was twelve or thirteen, made him an ardent and systematic microscopist—thus qualifying him to use the instrument with facility and success in his later technical career. When about fourteen, the discovery of a retort and pneumatic trough among his stepfather's possessions led to his preparing oxygen. This he regarded as the turning point in his career. He then came to the conclusion that he must be a chemist: in early life he had aspired to be a railway signalman. Beginning his experimental work in the kitchen, he soon came to regard a whiff of sulphuretted hydrogen as more precious than the odour of violets—but not so the cook: so he migrated to a store-room. He left school at sixteen and a half By then, in his attic workshop, quite unaided, he had mastered simple qualitative analysis, with the help of Fresenius. He also did a little quantitative work, under guidance of the great Peter Griess, in the laboratory at Allsopp's brewery.

Contrast Brown's training with that of the public schoolboy of to-day—who is not allowed to do anything of his own accord but constantly drilled into dull habits of conformity and helpless thoughtlessness: moreover, there are no waste places in the Flat-land of to-day. Where then is the "Dear Old Thing" to find followers in our times? Even country schoolboys are forced to play games and be examined by literary Dryasdusts, instead of willingly wooing and examining her. Little wonder that we complain that we no longer have leaders. The made-blind will never lead.

Horace Brown left school at the end of 1864, in the Sixth. In April 1865 he passed from Burton-on-Trent to the Royal College of Chemistry, Oxford St., London, to become a student first under Hofmann, then under Frankland. He left at the close of the year, however, to enter the brewery of Worthington and Co. at Burton, as an apprentice, the youngest of three assistant brewers. He was to receive 50*l.* the first year and only 90*l.* in the fifth. The young chemist to-day grumbles at 250*l.*-300*l.* There was no brewing chemistry in those days, even a prejudice against it; the brewer, in fact, was an empiric. Brown could only work in his scanty leisure hours, *sub rosa*, *privatim*, in a garden laboratory, which his stepfather had built for him, in 1866. He here began some research work, at Griess's suggestion. It took him nearly two years to persuade the authorities to purchase a balance and apparatus with which he might determine the original gravities of beers but this was installed in the office. Then came an opportunity which he at once took. In those days, liquor (water) was the dominant spirit in beer—everything that happened—every bad thing—was set down to water. So when Frankland and I, early in 1868, made known our method of determining organic matter in water, he readily obtained leave to spend the slack summer period in London, in Frankland's private laboratory. Having learnt to use the special appliances our method involved; among others, the Sprengel pump—which we were the first, after Graham, to adapt to practical purposes—and its tricks, he returned to the brewery and was allowed to fit up a laboratory. What that laboratory has been worth indirectly to the industry, it would be difficult to say—certainly a good round number of millions.

Brown forthwith made a survey of the Burton water supply, including the river. He thus became an authority on the subject and was instrumental in securing the abolition of the parish pumps, veritable cesspools—although only of age. As the ills that beer was heir to could not be traced to the water, he now devoted himself to the microscopic study of yeasts and soon became aware of their "mixed" character. At this period,

though not until 1870, Pasteur's great work, perhaps his greatest, "Études sur le vin" (1866), came into his possession and the already loosened scales soon fell from his eyes. It became clear that the souring of stock ales was comparable with the souring of wines. When Pasteur's "Études sur la bière" was published in 1876, he had little to learn from its microscopy. Meanwhile, he had perfected a method of "forcing" beers. This involved the use of a rectangular copper box or tray containing water, kept at a regulated temperature, considerably above the average atmospheric (80°-85° F.). Samples of the beers, in small closed flasks, provided with a side tube dipping into a mercury seal, were kept on the tray during several days; the deposit was then examined with the microscope and the extent determined to which pirate organisms had developed. It was then easy to forecast the behaviour of the beers in store and so determine the order in which they should be put on the market. The monetary value of the method to the industry was very great.

Largely owing to Horace Brown's work and influence, brewers quickly learnt to appreciate the value of Pasteur's teachings and soon began to put their houses in order. The progress of bacteriology in Great Britain, especially its application to water supply, was also hastened. Horace Brown, in fact, played the same part in brewing, in leading brewers to clean up their plant and adopt aseptic methods, that Lister played in surgery—he was even in advance of Lister in appreciation of Pasteur, though a much younger man. He became manager of the whole of the manufacturing department of Worthington's in 1873, at the age of twenty-five, and occupied this responsible post until 1889, when he became one of two managing directors on the incorporation of the firm as a limited liability company. He resigned in 1893 and left Burton for London, after which time his work was done privately.

What more Horace Brown accomplished before and after he left the brewery cannot usefully be told here. Suffice it to say that he was recipient in succession of the Chemical Society's Longstaff Medal, of a Royal Medal and eventually of the Copley Medal of the Royal Society—only given in recognition of outstanding service to science. His work is noteworthy on account of its thoroughness, the elegance of his methods and the philosophical manner in which he discussed the fundamental problems which engaged his attention. He was one of the few chemists who have done pioneering work of real importance in the biological field, notably in botany.

In the interval since Brown and I became friends, science is certainly risen: its power is certainly proven. Still, it is in some measure fallen—the public effect is not that anticipated by Huxley, Tyndall and others. The clerics openly scoff at our failure and do not sense our one supreme object—the discovery of truth, how infinitely superior belief through such discovery must be to all belief through mere faith, how perfect a religion must eventually be framed through it.

The lesson of Horace Brown's education and life is to be pondered by those who realise how complete a failure is the teaching of "science" in our schools and even in our universities, as a means of inculcating in the community an appreciation of its method and majesty and its usefulness. HENRY E. ARMSTRONG.

DR. E. KLEIN, F.R.S.

WITH the death of Dr. E. Klein at Hove on February 9, one passed away who had played an important part in English medical science for more than half a century. It is not an easy thing to give a complete account of him or to estimate accurately the value of his work. He had been with us so long that but few of his early contemporaries survive, while the younger workers from whose lives the War subtracted years knew him merely as a name, and had probably never seen him. Indeed, he was a somewhat elusive personality to all of us, as he kept a good deal to himself. The present writer knew him as a fellow-worker in the same branch of study, and had also dealings with him of a scientific kind. Much of what has been written of him since his death will be found to be incomplete and inaccurate. Our claims to write of him rest on information derived from two friends who knew him intimately half a century ago, on a personal acquaintance with him for half this time, and on an intimate study of almost all his works, a study with which we have refreshed our memory since his death.

Emanuel Klein (the name Edward was assumed only after his arrival in England) was born in 1844 at Osijek (Essek), the chief town of Slavonia, situated near the junction of the Drave and Danube. His father was a tanner of Russian leather. Nothing is known of his early years, but he related himself that he was in London when about eighteen—possibly in the capacity of a tutor. His medical education was in Vienna, and after graduation he carried out original investigations, chiefly embryological, in the laboratory of Salomon Stricker (1834–98), at that time professor of general and experimental pathology in the University. In 1871–73 Stricker was publishing his great "Handbuch der Lehre von den Geweben des Menschen und der Tiere," and for this work Klein wrote the articles on the thymus gland, the external generative organs, the serous membranes, and, in collaboration with Verson, the article on the histology of the intestinal canal, and, with Stricker and Stieda, on the conjunctiva and sclerotic. Klein's original work was, however, mainly embryological in connexion with the development of the vascular system of the chick. Stricker's Handbuch was translated into English by Henry Power for the New Sydenham Society, and Klein came into contact with several English workers.

When the Brown Institution was started in 1871–2 by the purchase of two houses in Wandsworth Road, Burdon-Sanderson applied to Stricker for a suitable resident assistant director, and Klein being recommended, he came to England and lived in one of the houses (now turned into shops). He was well received, and proved a *persona grata* from the start. In those days a number of the more ardent young consultants, such as J. F. Payne, Cavafy, and Pye-Smith, used to forgather at his house to discuss science, and incidentally to play whist. Klein had also some private pupils, among whom were Francis Darwin, Frederick Treves, Jeremiah MacCarthy, and James Adams. In 1873 he was appointed to give a course of lectures on histology in Morrant Baker's physiological course at St. Bartholomew's Hospital, and thus began his long association with this ancient and noble institution, first

as teacher of histology and later of advanced bacteriology. Here also was done most of his work for the Medical Department of the Local Government Board after he left the Brown Institution.

Almost all Klein's early work was on histology, a branch in which he was and is an acknowledged authority. In 1873 he wrote the section on histology for the "Handbook for the Physiological Laboratory," edited by Burdon-Sanderson, Foster, Brunton, and Klein. In the same year he published an authoritative work, in two parts, entitled "Anatomy of the Lymphatic System." These volumes were profusely illustrated with beautiful drawings by Klein from his own preparations, and he exploited with great success the method of silver impregnation which was introduced into histological technique by von Recklinghausen (1860). In 1875 Klein was elected a fellow of the Royal Society His reputation as a histologist was greatly increased by the publication, in conjunction with the orthopædic surgeon Eldred Noble Smith (1847–1906), of the classical "Atlas of Histology" (1880). The forty-eight magnificent plates in this work were drawn by Noble Smith from Klein's preparations, and some of the illustrations have been copied into almost every English book on anatomy and physiology down to the present time. Klein also published a standard "Elements of Histology," which ran through many editions and was translated into several foreign languages.

We have dealt in some detail on Klein's activities in histology because we feel convinced that, although this occupied chiefly his earlier years, it is the work by which he will be best and longest remembered. He was brought to England not as a normal histologist, but to engage in the histological problems connected with disease, and he drifted into experimental pathology and bacteriology, as we think, *malgré lui*. He lived and worked untiringly throughout the whole of the classical period of bacteriological science from 1876 to 1900, and it is greatly to be regretted that his name cannot be placed alongside those of Pasteur, Lister, Koch, Loeffler, Roux, Pfeiffer, Weichselbaum, Kitasato, Behring, and Ehrlich, as the discoverer of any really important ætiological agent of disease. Indeed, it may sound like a paradox, but on more than one occasion he failed at first to confirm work which has become part of established bacteriological knowledge. This is difficult to understand, for, at any rate in his later years, he was a splendid technician, and frequently exhibited beautiful cultures of bacteria. We are inclined to think that his failure to make any bacteriological discovery of the first rank was due to the fact that he arrived on the field just a few years too soon. When he began the investigation of disease the methods in vogue were microscopic only. Cultivation was practically unknown or carried out by methods now admitted to be insufficient. Bacteriology really emerged through the genius of Koch, and at a time when Klein was labouring with the old methods. Had he been in a position to become associated with a master of technique like Koch, he must with all his skill have succeeded in grasping at least one of the golden prizes which were falling into the hands of the workers in Germany and France.

There is a good deal of evidence in Klein's writings that his control experiments were too scanty or incomplete, and this led him to hasty conclusions on more than one occasion. Although it is to be regretted that Klein had not the luck to make a really important discovery in bacteriology, he exercised a profound and beneficial influence in England on the applications of the science to public health problems, and may be said to have controlled this branch for nearly half a century in a manner which was greatly to his credit. In personal intercourse with the younger workers he was always most helpful and generous, and placed his great experience at their service. All the memories of him in the country of his adoption will remain favourable. He was a tall, handsome man who spoke broken English to the end. Of affable manners, he was often polemical, but took defeat in a thoroughly sportsmanlike fashion. Throughout life he showed the characteristics of his race in a passion for music and chess.

W. B

HUGO VON SEELIGER, who died on December 2, was born at Bielitz-Biala, Austria, on September 23, 1849. After studying at the universities of Heidelberg and Leipzig, he was appointed observer at Bonn Observatory in 1873 and remained there for four years, taking part in the observations of the zone 40°-50° for the Astronomische Gesellschaft Catalogue, and being a member of the expedition to observe the 1874 transit of Venus. After a short period at Gotha he went to Munich in 1882 as Director of the Observatory and professor of astronomy He remained there for the rest of his life, and became famous as a teacher, Schwarzschild having been one of his pupils. He also made several theoretical researches both on stellar problems and those relating to the solar system. He was a pioneer in the application of statistical methods to the study of star density, and the size and shape of the stellar system, his estimate of the absorption of light in space was 0·3 mag. in 12,000 light years. He was interested in the excess of the motion of Mercury's perihelion over its theoretical value He examined whether any distribution of the matter forming the zodiacal light could explain this, without introducing other anomalies in the motion of the nearer planets. Another study related to the brightness of Saturn's ring. Basing his work on Maxwell's deduction that the ring was composed of small particles, he obtained expressions for its change in brightness at different distances from opposition, which were verified by Muller's photometric observations.

WE regret to announce the following deaths.

The Right Hon. Sir Thomas Clifford Allbutt, K.C.B., F.R.S., Regius professor of physic in the University of Cambridge since 1892, on February 22, aged eighty-eight.

Mr. T. H. W. Idris, president in 1903 and 1904 of the British Pharmaceutical Conference, on February 10, aged eighty-two.

Sir T. Edward Thorpe, F.R.S., emeritus professor of chemistry in the Imperial College of Science and Technology, South Kensington, and president in 1921 of the British Association, on February 23, aged seventy-nine.

Current Topics and Events.

THE President and Council of the Royal Society decided at a meeting on February 19 to recommend for election into the Society the following fifteen candidates Dr. W R G. Atkins, Prof C. A Lovatt Evans, Mr R H. Fowler, Dr F. A Freeth, Dr Walcot Gibson, Dr Harold Jeffreys, Prof. F Wood Jones, Prof J. Kenner, Prof. E Mellanby, Mr J A Murray, Prof. J Proudman, Mr R V. Southwell, Dr L. J. Spencer, Dr R. J. Tillyard, Prof. R Whiddington.

THERE has been so much adverse criticism of the Wireless Telegraphy and Signalling Bill recently introduced by the Postmaster-General that we are beginning to wonder whether after all something cannot be said in favour of it. Every one must admit that some control of "etheric" waves is absolutely necessary, even if the terms in which the Postmaster-General asks for authority are open to question. Scientific men, although they know perfectly well what the framers of the Bill mean by "etheric waves," have taken a Puckish pleasure in destructive criticism of the nomenclature. When asked to give a scientific definition they have to confess their inability A proposal has recently been made for a large and powerful radio station which will control the time-keeping of clocks Railway engineers want to use radio signalling to control their trains It is obvious that if some one were not put in authority, the ether—if there is an ether—would soon be in a chaotic condition. If anything affects telegraphy or telephony, the Postmaster-General has been given in the past, and still possesses, the most absolute powers to prevent this interference taking place. During the War, the public welcomed the autocratic powers given to the Post Office If there were another war these powers would be at once resuscitated for the public benefit The Bill has been in preparation for two or three years, and most of those affected by it have been consulted If suitable amendments be introduced so that the regulations do not affect amateur research injuriously, and section 7, which perhaps goes too far in putting the methods of radio power transmission under the control of the Post Office be suitably amended, we see little to criticise in the Bill. Regulations are always grievous at the start, but they may nevertheless be for the public good.

IT is of interest, just now, to recall the connexion of the Royal Society with various experiments made in 1664 from the steeple of old St. Paul's, under the guidance of Robert Hooke. Oldenburg, the Society's secretary, writing to Boyle, on August 25, 1664, reports that having found the top of Paul's steeple a convenient place for experiments, order was given at the previous day's meeting of the Royal Society (held at Gresham College) to try there the descent of falling bodies, the Torricellian experiment, and the vibrations of a pendulum suspended so as to reach to the floor of the church, a perpendicular height of about 200 ft. Hooke began at once to make trials, enlisting, as helpers, "some other company," which, we gather, included Lord Brouncker, Dr. Wilkins, Sir Robert Moray and Dr. Goddard Hooke comments on sundry difficulties in a letter to Boyle, dated Sept. 8, 1664. He says: "the steeple being without any kind of lofts, but having here and there some rotten pieces of timber lying across it, I caused a rope to be stretched quite cross the top, and fastened; in the midst of which I fixed a pulley, through which I let down the string and weight to the bottom, for only in the very middle of the steeple was there a broad clear passage from top to bottom." The vicissitudes of issue of the "Philosophical Transactions" have curious connexion, too, with old St. Paul's and the Great Fire of London in 1666. The Royal Society's printers (Mr Martyn and Mr. Allestry) and the booksellers in St Paul's Churchyard lost their stock of books in the conflagration, after carrying them from their own houses into St. Faith's Church, under St Paul's Among the losses were all the copies then printed and unsold of the "Philosophical Transactions." It is small wonder that early copies of this scientific journal are rare

WE have recently had occasion to consider in these columns the recommendations of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food. The Minister of Health has now published draft regulations based on these recommendations, and in framing them he has apparently adhered closely to the latter. The preservatives formaldehyde and boric and salicylic acids are completely prohibited: benzoic acid and sulphur dioxide are allowed in certain cases only and in strictly limited amounts The following may contain sulphur dioxide: sausages, jam, fruits, beer, cider, wine and cordials and fruit juices: benzoic acid is only permitted in coffee extract, fruit juices and cordials and sweetened mineral waters, including brewed ginger beer; but no article is permitted to contain both sulphur dioxide and benzoic acid. As regards colouring matters, all colours which are compounds of the following metals are prohibited: antimony, arsenic, cadmium, chromium, copper, lead, mercury, zinc. In addition, gamboge and half-a-dozen coal-tar dyes, including picric acid, are also forbidden. Further to protect the consumer, it is laid down that sausages, jam, and coffee extract must be labelled if they contain preservative, whilst articles sold as preservatives must be labelled with the percentage of sulphur dioxide or benzoic acid present. The regulations will apply to imported as well as to home products. Full powers are taken to carry out inspections and take samples. The regulations, when put in force—no date is as yet mentioned—should do much to improve the quality of Great Britain's foodstuffs.

THE American Association for the Advancement of Science has about 13,000 members, and in his address as retiring president (*Science*, January 2), Dr. Charles D. Walcott considers how this great body can render science of service to mankind. It should, he says, "act as a liaison agency between professional science and the public, as well as between the various sciences." Whether it be in the traffic and social problems of modern life, or in the conservation of

natural resources, the great need is the education of all citizens in the scientific method of approach. "All scientific men and women may do their bit—first, by training themselves to observe accurately, to think straight, and then to record clearly and honestly, and to draw warranted conclusions based on the facts presented . . ., second, by reviewing the mass of technical information with which they are familiar and telling the story they have learned in simple, clear language, free from obscure, complicated, technical and verbose wording" They should engage in co-operative public work, applying the scientific spirit in all branches of social endeavour, and notably in all agencies concerned with the education of the people from the university to the cinema. Could not, Dr. Walcott concludes, the Association organise a committee to deal with the popularising of scientific knowledge, bringing its lessons and its principles home to all—and particularly to children, to women, and to business men? This is admirable counsel, and just as applicable to those on the eastern side of the Atlantic as to Dr Walcott's fellow-citizens.

AT the sale of the Crisp Collection of antique microscopes on February 17, high prices were realised for some of the instruments. The silver "universal" by G. Adams was obtained by Mr. Webster for 360*l*. This instrument, on account of its highly ornamental construction, its scientific interest, and the fact that it is made throughout of silver, was easily the most valuable item from the auction point of view. The original modification of the Hooke microscope, dating from about the year 1675, realised 160*l*. The name of the maker of this very fine early example of English opticians' work is unknown An original compound microscope made by Guiseppe Campani, the great Italian optical instrument maker, was obtained by the Science Museum, South Kensington, for 45*l*. Other instruments of historical and scientific value secured for this museum included the improved "universal" microscope by G. Adams, the Cuno form of hand microscope made by Depovilly of Paris, and a modified form of John Marshall's microscope. For the new Museum at Oxford, several instruments were obtained, including a replica of Hooke's original compound microscope, as figured and described in his "Micrographia," 1665. This item realised 20*l*. Mr. T. H. Court, whose valuable collection in the Science Museum is well known, secured a large number of the instruments. Of these, the elaborately decorated microscope made for Pope Benedict XIV. (31*l*.), the very fine microscope made in 1752 by D. Joannes de Guevave (33*l*.), and an early Italian microscope inscribed "Elaboratum a Blasis Burlini Venetiis Optico" (31*l*.), may be mentioned. Three fine examples of the Marshall microscope, made in the early part of the eighteenth century, were sold at prices ranging from 13*l*. to 22*l*.

PROF. T. H. PEAR, in a discourse at the Royal Institution on Friday, February 20, on "Acquiring Muscular Skill," stated that his purpose was, first, to examine an urgent practical aspect of the problem; the desirability of describing and recording skill in a universally acceptable language and notation. The photographic, stereoscopic, cinematographic, and ultra-rapid cinematographic study of the ideal postures and movements desirable in certain skills, and the result of describing and discussing such records in words, have occasionally led to a degree of "intellectualisation" which is not generally recognised. The accidental fact that some skills have been more fortunate in their exponents partly, but only partly, accounts for this. By the aid of these various devices and of certain utilisations of "picture-diagrams" and films it is possible not only to record actual performances, but also to criticise them analytically. The study of modern figure-skating in the international style is a good illustration of this point. Suitably prepared diagrams should help the learner, before he attempts to execute a complicated series of movements, to grasp them visually, both in parts and as a whole This method of transmitting skill is probably in its infancy. Its progress in the hands of suitable instructors should be rapid. Whether such visual means of approach to the mind are specially suitable only to the person who "thinks in pictures" is an important and unsettled problem By these means it should be possible to compose new skilled movements and new combinations of them Before the days of musical notation and of writing, musical composers and poets had to be performers. Nowadays they may inspire other more gifted executants. This may be possible for skilled movements when a combination of workers, players, anatomists, physiologists and psychologists produce a grammar, a syntax, a harmony and a recorded poetry of movement

IN his presidential address to the Optical Society on Thursday, February 12, Prof. Archibald Barr referred to the optical instrument maker as the tool-maker for all branches of scientific investigation including his own. He stated that scientific investigators depend to a great extent on the knowledge and skill of the optician for the provision of their tools. Every improvement made in the optician's products enables the user of these tools to go farther and deeper in his researches. It is the duty of the optician to keep himself familiar with the latest advances in science, so as to be ready to forestall the needs of the investigator, or to be able fully to understand the requirements that arise, and to bring to bear on the production of the new tools an intimate knowledge of the means by which, and the extent to which, the requirements can be fulfilled in a practicable device. Opticians are primarily concerned with less than one octave out of the sixty or more of known radiation, though for some purposes they have to take account of one or two octaves on each side of that of visibility, into the infra-red and the ultra-violet. Narrow as it may be on the scale of radiology, the one octave of the visible spectrum has and always will have a very special significance in the scheme of things as they are, and that octave includes a wide range of problems of all degrees of complexity. Within the limits of optics properly so called, there is still scope for development to which no limits can be set.

PROF. WILLY WIEN, of Würzburg, has been elected an honorary fellow of the Physical Society of London.

MR. E. HILTON YOUNG, M.P., has been appointed chairman of the Departmental Committee on the University of London, in succession to Lord Ernle, who has resigned.

DR LOUIS A. BAUER, director of the department of terrestrial magnetism of the Carnegie Institution of Washington, has been elected a corresponding member of the Russian Academy of Sciences.

WE learn from *Science* that Mr John F. Stevens, of New York City, has been awarded the John Fritz Gold Medal of the Engineering Foundation, New York, "for great achievements as a civil engineer, particularly in planning and organising for the construction of the Panama Canal, as a builder of railroads and as administrator of the Chinese Eastern Railway."

A TEMPORARY assistant and a temporary junior assistant are required in the metallurgical research department of the Royal Arsenal, Woolwich Candidates should be graduates with university training in metallurgy Applications for the posts should be sent, with copies of not more than three testimonials, to the Chief Superintendent, Research Department, Royal Arsenal, Woolwich, S E 18

A TECHNICAL assistant is required at the Royal Aircraft Establishment, South Farnborough, Hants, for experimental and development work in connexion with aerial beacons and aerodrome illumination generally. Candidates should possess an honours degree in electrical engineering, design experience in the application of optical and illuminating engineering, and, if possible, experience in lighthouse work Applications, marked A 47, should be sent to the superintendent of the establishment

APPLICATIONS are invited for the position of organising secretary to the standing committee on special libraries and bureaux of information His duties will consist of attending meetings of the standing committee and its executive, the compilation of a directory of special libraries and intelligence bureaux in the United Kingdom, and preparation for the second conference to be held in September 1925. Applications giving full particulars, and endorsed "Special Libraries," should be sent to reach Mr J. G Pearce, Central House, 75 New Street, Birmingham, not later than March 10.

THE annual general meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on Wednesday and Thursday, March 11 and 12, commencing each day at 10 A.M Twelve communications are due for presentation at the meeting. The annual dinner will be held at the Trocadero Restaurant on Wednesday, March 11, at 7 P.M. Amongst those who have accepted the Council's invitation to be present at the dinner are the Right Hon. Neville Chamberlain (Minister of Health), the Right Hon. the Lord Morris (vice-chairman, Imperial Mineral Resources Bureau), and the presidents of many kindred societies.

DR. H. C. WILLIAMSON has been appointed to investigate the salmon of British Columbia at Prince Rupert Dr. Williamson was a distinguished student and graduate of St. Andrews as well as holder of a research studentship of the Exhibition of 1851. Trained in fisheries work at St. Andrews, then for nearly two years at Naples, and afterwards in Germany, he entered on the scientific work of the Fishery Board for Scotland equipped as few have been with special knowledge and experience. For twenty-eight years he has carried on a continuous series of researches, illustrated by his own skilful pencil, on food-fishes, edible and other crustaceans, and has made careful experiments on the eggs of salmon and herring in connexion with their transmission to the antipodes, besides other fisheries' subjects, and has at present a work on fishes in the press. The loss of a highly trained scientific investigator in Scottish fisheries, following so soon after the retirement of his able senior Dr Fulton, is unfortunate for the Department, yet Canada will be the gainer Dr Williamson's publications in the Reports of the Fishery Board extend from 1893 to the present year

THE council of the Institute of Chemistry announces that the Meldola Medal for 1924, awarded for meritorious work in chemistry during the year, has been awarded to Dr. Leslie J Harris, of the School of Biochemistry and Emmanuel College, Cambridge. Dr. Harris's investigations have been concerned largely with the theoretical basis of acid-base titrations and in special relation to amphoteric electrolytes. His results have been published mainly in a series of papers appearing in the Proceedings of the Royal Society, B, during the past few years He has shown that the protein constituents, amino-acids, may be estimated from a consideration of their individual acid and basic constants, by titrating within definite P_H limits The same principle has been utilised also by Dr Harris for estimating proteins and other ampholytes Recently he has shown that such methods are of general application in chemistry, and serve to estimate substances containing the feeblest basic or acidic groups, it having previously been supposed that acids or bases of less than a certain strength were incapable of estimation by acidimetry. Incidentally he has disproved for many cases the theory of acid-base binding at peptide linkages, and he has brought forward fresh data upon the ionic nature of the protein molecule. Denaturation of proteins he has shown to involve a chemical change which occurs at a hitherto undescribed sulphur grouping in the protein molecule. Dr. Harris has also carried out investigations upon milk and infant nutrition.

IN the notice of the second edition of "An Introduction to the Study of Cytology," by the late Dr. L. Doncaster (NATURE, February 14, p. 224), the reviewer regretted that the scope of the book was not enlarged. We understand from Mr. J. Gray that the omissions mentioned are entirely due to the fact that their inclusion would have involved a considerable increase in the cost of the book. It seemed desirable to keep the book within the means of the average

student, and this would not have been possible in a new edition including even a brief account of recent knowledge of cell inclusions and somatic cells. The new edition has recently been translated into Italian by Prof. L. Cognetti de Martiis, of the University of Turin, and can be purchased for seven shillings

As a result of the amalgamation of the Ipswich Scientific Society and the Ipswich and District Field Club, there has been formed, under the presidency of Mr. J. Reid Moir, the Ipswich and District Natural History Society The honorary secretary is Mr F. W Brinkley, 31 Oxford Road, Ipswich Fortnightly meetings are held, taking the form of lectures in winter and spring and excursions in the summer, and various sections, each under the guidance of a "leader," deal with different aspects of the Society's activities. The Society claims a membership of about 250, and it is hoped to issue shortly the first volume of Proceedings. According to the programme for the 1925 session, Sir Charles Sherrington, president of the Royal Society, who is himself associated with Ipswich, has consented to become patron of the Society, and there is little doubt that the sympathy and encouragement expressed by his interest in the Society will do much to promote appreciation of the value of science in the neighbourhood

In addition to the Monthly Bulletin of the Hawaiian Volcano Observatory, a weekly *Volcano Letter* is now issued Each letter contains the Kilauea report for the previous week on the volcanic phenomena and on the earthquakes recorded at the Observatory, in addition to miscellaneous news On its reorganisation a short time ago, the Volcano Research Association was placed under the U S Weather Bureau. It has now (since last July) been transferred to the U S Geological Survey. Since 1920, it has established earthquake stations at Kone, Hilea, and Hilo, all in Hawaii, in addition to the central observatory at Kilauea, it has conducted boring experiments at Kilauea, equipped a chemical laboratory at the Observatory, and maintained a research fellowship at the station for one year. It is now engaged in preparing for publication the scientific results of its fifteen years' work on the volcano.

We have received No. 2 of *Brighter Biochemistry*, the illustrated journal of the Biochemical Laboratory, Cambridge. As its title implies, it is a product in a lighter vein than is usual in biochemical journals: it contains short articles in prose and rhyme, contributed by various members of the staff of the Laboratory, whose identity is revealed by the initials at the foot of each contribution. As might be expected, a local colour is reflected from most of the articles, and some of the allusions will probably only be fully appreciated by those who have an intimate acquaintance with the members of this school and their works. Perhaps the most amusing contribution is a short one in verse, entitled "The Great Push: another version," giving a brief, though doubtless accurate, account of recent experiments conducted by one of the staff of the Laboratory. A series of cautionary tales for biochemists, and the story of John Montgomery Wardley, are other good things in the number, whilst, as might be expected, blood sugar methods and their authors—we had almost said perpetrators—have not escaped satire at the hands of those who have to use them

The German Scientific and Medical Association (Gesellschaft deutscher Naturforscher und Aerzte) has been greatly encouraged by the success of the Innsbruck meeting in September last. No general meeting will be held in 1925 Severe economy is still necessary. A meeting at Düsseldorf is planned for 1926 *Die Naturwissenschaften* has been made the organ of the Association, and monthly communications are distributed with this journal. The issue of November 21 was devoted to the proceedings of the Innsbruck meeting and included the lectures delivered at the joint meetings of the Society, together with the more important of those delivered to the medical and natural science sections. Men of science of all shades will find something of interest in one or other of these lectures, for the range of subjects covers a wide field A thousand members have accepted the offer of a reduced subscription rate to this journal The membership subscription is 5 marks in Germany, 50,000 kroner in Austria Foreigners may send notes or cheques in registered envelopes to the G D N A at Chemie-Treuhandgesellschaft, Berlin W 10, Sigismundstr 3. For all other business the Secretariat is at Leipzig, Nürnberger Strasse 48[1]. Publications are issued through the Hirschwaldsche Buchhandlung, Berlin, N W., Unter den Linden 68.

We have received Nos. 9-10 of vol. 1 of the *Bulletin d'Histologie Appliquée*, edited by Prof. A Policard, of Lyons. It contains original papers on physiological and pathological histology, a section on methods, a critical review, and a bibliographic index. It is well printed, but the illustrations could be improved considerably. A somewhat original feature is a quotation from some author after each paper: the excerpts cover a variety of subjects, from the use of a theory (Gide) to a diet for white rats (Steenbock). The number contains four original papers. A. Lumière and R. Noël describe the lesions produced in guinea-pigs by the actual method of killing, and conclude that simple bleeding by cutting the carotids, or removal of the heart and lungs after opening the thorax, produce the least alteration in the tissues; all asphyxial methods cause congestion and hæmorrhages. E. Grynfeltt describes the erectile tissue in the fimbriæ of the Fallopian tube, by means of which the abdominal ostium of the latter can be brought close to the ovary. Mlle. A. Van Herwerden gives a short account of a reversible gelation produced in the protoplasm of the living tadpole by means of weak acetic acid. H. E. V Voss describes the ossification and calcification sometimes observed in portions of ovary grafted into the testicle or kidney of a male guinea-pig, and concludes that connective tissue cells are responsible, typical osteoblasts not being observed. In the section on methods, A. Ch. Hollande discusses the oxidase reaction, and finds, as the result of his experiments, that the formation of indophenol blue

in cell-granules is not diagnostic of the presence of an oxidase in them, since the granules take up the blue colour when the dye itself is presented to them. The actual formation of the blue colour, however, shows that oxidases must be present in the cells or their surroundings M. Bernheim reviews the functions of the germ centres of Flemming in the lymph-glands, and concludes that they play an important part in the defence mechanism of the body. The bibliographic index is under headings such as embryology, tissue culture, etc., sections v to ix appearing in this number

THE Medical Supply Association, Ltd., 167-185 Gray's Inn Road, London, has recently placed on the market a compact X-ray outfit of unusual design It is described by them as the "Radiosearch" Complete X-ray Apparatus and is intended for general laboratory work Electricity at 70,000 volts is supplied by a small oil-immersed transformer, enclosed in a rectangular wooden box with ebonite top, which stands in front of a hard-wood panel about three feet high From the upper part of this panel two well-separated stout porcelain insulators project horizontally and forwards To the end of one of these a practical type of milliampere meter with open scale is attached, while the other column carries a variable resistance by which the heating current for the Coolidge tube may be adjusted while the apparatus is in action, a dial enabling the setting to be noted. The high tension leads from the secondary of the transformer are suitably connected to these instruments and pass on over spring pulleys to the X-ray tube itself. The tube is the self-rectifying radiator "Coolidge" with current-carrying capacity of 10 milliamperes at 70,000 volts. It is held axially within a cylindrical box with only the electrode sleeves projecting on either side. The arrangement, adequately protected with lead rubber, is mounted upon a separate and portable table stand so as to enable a beam of X-rays to be projected in any desired direction The outfit is well and strongly constructed Its simplicity and solidity are distinct features, and there seems little to get out of order with reasonable care. It should be noted that no means is provided for the variation of the potential difference at the tube terminals. An attachment can, however, be supplied for this purpose at an additional cost. It would also make the outfit more complete for experimental work if a sphere-gap with resistance were fitted so that the potential difference across the tube could be directly measured. Most physicists using the set, however, would probably prefer to make this measurement by means of an X-ray spectrograph.

Our Astronomical Column.

ENCKE'S COMET.—*Astr Nach* No. 5345 contains some observations by G. A Tikhov of Pulkovo on the spectrum of Encke's comet made on Oct 20, 1914 (46 days before perihelion), and Oct 4, 1924 (27 days before perihelion) An objective prism was employed. The following are the intensities of the principal bands, on a scale from 1 to 10

Wave-length.	Intensity 1914	Intensity 1924	Source
388	10	10	Cyanogen
405	8	4	
473	1	6	Carbon
516	.	1	,,
563	.	1	,,

The 1924 spectrum is of a type often found in comets That of 1914 is unusual in the feebleness of the carbon bands, which is perhaps due to the longer interval before perihelion The continuous spectrum is weak, especially in 1914.

THE NATURE OF SPECTROSCOPIC BINARIES.—According to the theory of binary stars, there is a simple relation between the period and the semi-amplitude, K, of velocity variation This relation involves the masses of the stars; but by assuming an average mass, and treating the stars in groups, it becomes possible to investigate this relation without introducing serious errors This has been done by Dr O. Struve in the *Astrophysical Journal*, vol. 60, p 167, who has found that for spectroscopic binaries with periods greater than 2·5 days, the relation between P and K agrees satisfactorily with theory The Cepheid variables have comparatively small values of K which show no relation to the periods—thus incidentally affording evidence in favour of the pulsation theory, which assumes that Cepheids are not true binaries In addition, the author has discovered an interesting group of stars (to which he has applied the rather unfortunate name of "Pseudo-Cepheids") which closely resemble the Cepheids in the behaviour of K. These are all spectroscopic binaries of short period (less than 2·5 days), and if they are to be regarded as true binaries, the peculiar behaviour of K would seem to imply either that the total masses are very much smaller than the average, or that the mass-ratios are very large—neither of which assumptions is supported by evidence from the long-period binaries.

The evidence brought forward by Dr Struve thus seems to show that short-period spectroscopic binaries may be classed in two groups, some, characterised by large values of K, are true binaries, while others (the more numerous group) are probably not binary stars at all, and bear a close analogy to the Cepheid variables.

THE DIAMETER OF VENUS.—*Astr Nach* No. 5348 contains three articles on this subject by members of the staff of the Berlin-Babelsberg Observatory. It is a matter of considerable interest, owing to Venus being the only known orb that closely resembles the earth in size. The measures are difficult, owing to the extreme brightness of the disc, which produces irradiation, the amount of which is difficult to determine; it has generally been assumed that the amount of irradiation in arc is constant at all distances of the planet, but the researches here described (by G. Struve, J. Dick, and A. Kühl) show that this assumption is untenable. They used the large Babelsberg refractor with various powers up to 1000. G Struve's final diameter is 17·523″ at unit distance; comparing this with the usually adopted value for the earth, 17·61″, we see that the planet's diameter is less than that of the earth by some 40 miles only. That, however, may be modified if the visible disc of Venus is bounded by a cloud surface, as this is likely to be some miles higher than the solid ball of the planet.

Research Items.

ANCIENT ROCK-SCULPTURES IN THE LIBYAN DESERT.—A journey of considerable geographical interest across the southern Libyan Desert from Bara to Bir Natrun in Dongola Province is described by Mr. D. Newbold in *Sudan Notes and Records*, vol. 7. At an early stage of the journey, the author witnessed the departure of the Kababish on their great seasonal migration, when the tribe moves some 20,000 camels and 150,000 sheep and goats to the "gizzu" or grass country for six months. Evidence of early occupation of the country crossed was abundant, including cairns, pottery, some of which was afterwards identified as Meroitic, a small brick pyramid at Abu Sofian, and a find of five glauconite implements of neolithic type. Rock sculptures were first found at Zobat el Hammad, where drawings roughly incised on boulders showed tailed and phallic men, elephants, giraffes, ostriches, oryx, cattle, and several other animals which could not be identified. At Um Tasawin on the return journey, the cliffs, even in the most inaccessible positions, were found to be engraved with innumerable figures of cattle, giraffes, elephants, oryx, and other indeterminate animals. There were also a number of human figures, some tailed, some armed with bows, a few phallic and one steatopygous. At Abu Sofian, two groups of pictures, obviously of the same date and "school," were within a day's march of one another. Here the drawings were incised on round boulders, and were very numerous. Camels are shown literally in hundreds of drawings, giraffes and ostriches still appear, but the cattle dwindle in numbers, while the elephant is not represented and the bowmen give place to men armed with spears and carrying shields. The absence of the camel at Tasawin and el Hammad suggests that the drawings there cannot be later than the first century B.C. They may be the work of the Southern Libyan Tamahu, the ruling caste in Ethiopia in the Meroitic period, and might be dated any time from 300 to 750 B.C. or even earlier. The Abu Sofian groups are obviously later, as shown by the presence of the camel, but must equally be the work of Libyan artists, and are probably between 1500 and 2000 years old. The archaeological evidence as a whole supports the theory of continued migration into the northern Sudan of desert peoples of the west and north-west from the earliest times, and the introduction thence of a Hamitic element into the riverain populations, which is still strongly marked.

SEX-TRANSFORMATION IN BIRDS.—Crowing hens have long been known, but the first case of the complete transformation of a hen which had laid eggs into a functioning male was described by Crew in 1923. Gatenby and Brambell (*Journ. of Genetics*, Vol. 14, No. 2) have added to the list of less complete transformations. They describe a white Leghorn hen which developed the comb and wattles and part of the behaviour of a male. This was accompanied by a great accumulation of fat on the viscera, together with the presence of testicular tissue. Apparently in birds such transformations only take place from the female, which is the heterozygous sex, to the male. The writers discuss the relation of such cases to the chromosome theory of sex determination. Cunningham (*Sci. Progress*, Jan. 1925) has also discussed the problem of the sex characters of birds in its general bearings on the Lamarckian theory and other questions. He refers to the condition in certain breeds of fowls in which the cocks are henny-feathered. Morgan showed that the castration of such cocks causes the development of the normal cock-feathering. Punnett suggested that the hen-feathered condition of the cocks in these breeds is due to the presence of a non-sex-linked factor which causes the testis to develop a hormone suppressing cock-feathering, which is normally produced only by the ovary. Cunningham proposes an explanation of this condition based on the assumption that non-disjunction of the sex chromosomes has taken place, so that in a heterozygous Sebright Bantam hen, the sex chromosomes would be WZZ and not WZ. The test of this hypothesis by examining the chromosomes would be extraordinarily difficult because of the large number and variable form of the chromosomes in the chick. Morgan considered that his castration experiments removed the necessity for a theory of sexual selection or Lamarckian inheritance to account for somatic sexual characters. Cunningham points out certain objections to this view and emphasises, for example, that the pad of a frog's foot is not merely a by-product of a hormone producing some other character, but is definitely related in position and structure to the use to which it is put.

OOGENESIS IN A CENTIPEDE.—S. D. King (Sci. Proc. Roy. Dublin Soc., xviii. pp. 29-36, 2 plates, Nov. 1924) records observations on oogenesis in *Lithobius forficatus*. Yolk-formation in the oocytes takes place by extrusion of particles (the fate of which has not yet been determined) from the central nucleolus, and later by fragmentation of the nucleolus, the particles of which, after proliferation, grow into the definitive yolk-spheres. The Golgi bodies and the mitochondria do not take any direct share in yolk-formation. The mitochondria are at first diffuse, but become concentrated in the early stages of growth, when they form in the oocyte several clusters, some of which proliferate very rapidly, giving rise to round bodies which are not comparable to the yolk-nuclei of ascidians or to the mitochondrial masses described in the oocytes of insects. Later the mitochondria become evenly distributed in the cytoplasm. The Golgi apparatus behaves in the usual way; in the youngest oocytes it is concentrated, but later spreads through the cytoplasm and breaks into fine granules.

SEASONAL CHANGES IN THE WATER OF PONDS.—Messrs. W. R. G. Atkins and G. T. Harris (Sci. Proc. Roy. Dublin Soc., 18, pp. 1-21, Nov. 1924) compare the seasonal changes in the heleoplankton of two fresh-water ponds with alterations in the solutes, and show that in each pond there is a vernal rise in P_H followed by a period of stagnation with lowered P_H. In one pond this condition persisted until the autumn, but in the other—Staddon reservoir—it was succeeded by a period of high alkalinity lasting until October. These changes are associated with the spring increase in plankton and the development of masses of floating algæ in the reservoir. In both ponds the supply of phosphate is exhausted in spring and this sets a limit to the further growth of algæ, but phosphate increases again in winter, partly by regeneration and partly by the inflow of water rich in phosphates. It is highly probable that lack of phosphate, rather than of nitrate or of ammonium salts, limits the plankton in fresh water as it does in the sea. The rapid increase in plankton in the spring is associated with the increase in light rather than in temperature.

CULTIVATING A PLANT "VIRUS" IN VITRO.—Peter K. Olitsky, of the Rockefeller Institute of New York, has a note in *Science* for December 26, pp. 593-4, which will attract the attention of plant pathologists. In experimental work with the mosaic disease of

tobacco, he has drawn about 0·01 c c. of the juice from infected plants, by careful technique with sterile pipette, etc., and inoculated this into a medium consisting of the fresh aqueous extract, prepared from carefully selected tomato plants free from mosaic. The medium then, in seven to ten days, showed "a faint, uniform, translucent, almost imperceptible haze." No microscopic technique revealed definite formed elements in the medium, but as the result of dilution by subcultural methods, the conclusion is reached that at dilutions far beyond that at which the original 0·01 c c of virus containing sap would still be active, successful inoculation of the disease could be achieved These results are particularly interesting as being obtained with the virus of tobacco mosaic, upon which Allard carried out his well-known experiments showing the filterable nature of the virus, and its highly resistant nature to heat and ordinary precipitants, etc The more detailed account of these experiments that is promised will be awaited with interest.

SILVER LEAF ON RHODODENDRONS.—Mr. A D. Cotton has a record in the *Gardeners' Chronicle* of February 14 of the appearance of silver leaf upon rhododendrons in cultivation in Great Britain. The characteristic silvering of the foliage is missing, but after removal of the dead and dying branches, fructifications of *Stereum purpureum* developed upon the stumps The disease seems to spread very slowly in the wood of the rhododendron, but there seems little doubt that in some of the cases observed by Mr Cotton the organism was acting as a parasite and responsible for the dying back of the branches. Now that attention has thus been directed to the attack, doubtless other growers of rhododendrons will pay special attention to signs of dying back of branches in rhododendrons.

VARIATION IN BLUE-GREEN ALGÆ.—In a paper on variation and species in Cyanophyceæ, Mr. W B. Crow (*Journ Genetics*, vol 14, No 3) describes observations and cultures of these organisms and draws a number of interesting conclusions. The cell structure in this group of unicellular and filamentous algæ is very simple, there being no true nucleus or karyokinetic division, and sexuality is also absent Mr. Crow correlates the continuous variation with these features The systematic differences are shown to be similar to those variations produced by changes of environment in cultures The characters of the group are regarded as belonging entirely to the kind called by Gates organismal, the absence of karyogenetic or Mendelian characters being correlated with the absence of nuclei and sexuality. Various parallelisms in variation with Isokontæ and other groups of algæ and fungi are also pointed out, and the general constancy of the forms when grown artificially is emphasised. Such studies are valuable for comparison with the genetics of higher organisms.

THE ORIGIN OF THE CYCADS.—English botanists, remembering the caution with which that veteran palæobotanist Dr. D H Scott now speaks, will read with some scepticism the confident pronouncement with which the address of Prof. C. J Chamberlain, chairman of Section G of the American Association for the Advancement of Science, commences (*Science*, January 23). Prof. Chamberlain is quoted as saying that "the widest gap in the evolution of plants used to be the one between the ferns and seed plants; but the researches of the past thirty years have bridged the gap so completely that the two groups are now separated only by the artificial definitions of the taxonomist." None is better qualified, however, than Prof. Chamberlain to discuss the salient features of structure and distribution in the Cycadales; and with reference to the deficiency of our knowledge of their fossil history, there will be general agreement that at the present day a study of distribution of a group in geological times may often be a study of the distribution of the enthusiastic and trained palæobotanist. In exemplifying this thesis Prof. Chamberlain pays a well-deserved tribute to the productive labours of the American palæobotanist Prof. Wieland.

SURVEY WORK IN NORTHERN CANADA.—The Topographical Survey of Canada is pushing its work farther north every summer and has parties at work in the barren lands and the northern islands of the Arctic Archipelago. Some notes in the Journal of the Dominion Land Surveyors Association by Mr. G. H. Blanchet give a preliminary account of the drastic changes in the map that accurate survey is making in regions relatively so accessible as the Great Slave Lake and the upper part of the basin of the Coppermine River and Backs River The position and extent of Lakes Clinton-Colden, Aylmer, Mackay and de Gras up to the present have figured on maps chiefly from hearsay reports. Last summer Dominion surveyors found them very much out of position and corresponding but little with previous notions. The party found the outlet of the upper Coppermine River from Lac de Gras, but was unable in the short season to go down the valley Another paper in the same publication notes the beginning of surveys in and around the new station of the Canadian Mounted Police in Ellesmere Land, Devon Island, and Ponds Inlet.

THE PROBLEM OF ATMOSPHERIC ELECTRICITY.—The issue of the *Physikalische Zeitschrift* for January 1 is a Jubilee number of 92 pages. It contains an account of the life and work of Georg Hirzel, by whom the *Zeitschrift* was planned and founded in 1899, with Profs Riecke and Simon of Göttingen as editors. The issue also contains an account by Dr. R. Seeliger of the report on the fundamental problem of atmospheric electricity made by Prof. Hans Benndorf to the meeting of the German Scientific and Medical Association at Innsbruck. The variation of electrical potential with height in the atmosphere and the electrical conductivity of the atmosphere itself imply a flow of electric current to the earth, which for the whole earth amounts to about 1000 amperes. To explain how this current is maintained has been the problem of atmospheric electricity for some years. It has, however, been reduced to insignificance by the larger problem raised by the measurements of Dr. L. A. Bauer, who finds that the lines of magnetic force on the earth's surface necessitate a current of about 3 million amperes. Prof Benndorf ascribes this current to β-rays from the sun too swift to produce ionisation of the atmosphere.

DIRECTIONAL QUANTIFICATION IN A MAGNETIC FIELD.—Prof. W. Gerlach describes, in the F. Paschen "Festschrift" of the *Annalen der Physik* published in January, an improved apparatus for studying spatial or directional quantification, and so measuring the magnetic moment of the atoms of metallic vapours. With copper, silver, and gold, the vapours of which are monatomic, the magnitude of the shift of the atomic stream in a magnetic field shows that they behave exactly as single quantum atoms, or more generally, as atoms with an apparent (effective) moment of one magneton, should do according to the theory. Thallium vapour is also monatomic, but the magnetic effect in this case is much smaller. There is no magnetic effect for lead or tin, though lead vapour

is monatomic and the same is probably true of tin vapour; this is partly due to the low temperature employed, though it was high enough in the case of tin to have enabled ±0·5 of a magneton to be observed. Bismuth and antimony vapours consist wholly or partly of molecules and multiple molecules; a definite theoretical explanation of the results is therefore impossible for these metals. Nickel vapour is monatomic, the experiments show that in the normal state the atom has a magnetic moment of several units; 0 and $\pm i$ magnetons (i about two) have been proved certainly, apparently there are also atoms with still higher moments. The result of the magnetic analysis is rather complicated, and it is hoped that it will be possible to obtain a more complete analysis of the plates for this metal. There were considerable experimental difficulties in the case of iron, and the appearances expected from a consideration of its spectrum could not be obtained in the plates.

THE X-RAY ABSORPTION BAND HEADS OF NICKEL AND OF ZINC.—A method of determining the wave length of an X-ray absorption band head is described by Dr. W Walter in the *Zeitschrift für Physik*, December 31. An X-ray tube is used, giving a line spectrum with numerous lines, one of which lies as near as possible to the wave length of the band head to be measured. When the X-rays are passed through screens made of the element to be investigated, lines corresponding to longer wave lengths than this show no absorption, while those corresponding to shorter wave lengths are strongly absorbed. In the case of nickel, the following table gives the estimated intensities of three lines, photographed directly, and after passing through nickel filters *b* and *c*

Line.	λ × 10¹¹ cm.	Intensity.		
		a	*b*.	*c*
$N_{1\beta}$ . . .	1497 03	10	10	10
$W_{\alpha'}$ . .	1484 52	8	5	2
W_{α} . . .	1473·48	50	8	1
Thickness of filter, mm. .	...	0·0000	0·0095	0·0163

$N_{1\beta}$ is not absorbed by nickel, since its wave length is greater than that of the band head, which according to Kossel's theory must have a wave length a little smaller than that of the Kγ line of nickel, 1485·4 × 10⁻¹¹ cm. The $W_{\alpha'}$ line satisfies this condition, and it will be seen that its behaviour agrees with its lying in the band head, since the relative change of intensity caused by the filters is considerably less than in the case of W_{α}, which lies well inside the absorption band. Duane and Hu give 1489·0 for the position of this band head, which is clearly much too large. Similar results were obtained for zinc, though in this case the X-ray tube employed gave no line which agreed so closely with the position of the band head as in the case of nickel. The difference between the value obtained and that of Duane and Hu is considerably greater for zinc than for nickel.

NEW SYNTHESIS OF UREA.—Dr. K. C. Bailey, in the Proceedings of the Royal Dublin Society, November 1924, describes a new synthesis of urea from carbon dioxide and ammonia. The mixed gases, preferably in the ratio 4 : 1, are passed at atmospheric pressure through the annular space between two concentric tubes, the outer, quartz, tube being heated to 500-700°, and the inner, glass, tube being kept water-cooled. The yield increases with temperature up to at least 700° C.

OXY-CELLULOSE.—In the Journal of the Textile Inst, vol 16, No. 1, January 1925, Constance Birtwell, Douglas A. Clibbens, and Bert P Ridge publish as Part I. of "The Chemical Analysis of Cotton" a comprehensive study of oxy-cellulose As the result of carefully controlled oxidation of cotton with mild oxidising agents, they are able to analyse the different results of such agents upon cotton cellulose, and they point out that two main types of oxy-cellulose should be distinguished. In one type, the product resulting from oxidation shows great affinity for methylene blue and high retentive power for alkalis; this type of oxy-cellulose is not chemically altered by boiling in dilute alkali. The other type of oxy-cellulose has enhanced reducing properties, best measured by the weight of copper reduced under standard conditions. This type loses entirely its chemical characteristics as an oxy-cellulose on boiling with dilute alkali, losing abnormally in weight at the same time; it is afterwards indistinguishable chemically from pure cotton cellulose, though the physical properties, *e g* tensile strength, may be altered Which type of oxy-cellulose is produced predominantly during the technical process of bleaching depends chiefly upon the acidity or alkalinity of the hypochlorite solution, on the alkaline side of the neutral point the product tends to be of the first type, with high absorption of methylene blue and low copper number, on the acid side the type with high reducing power is obtained.

FLOW AND RUPTURE OF METALS DURING CUTTING.—The report of the Cutting Tools Research Committee of the Institution of Mechanical Engineers, read on January 23 by Dr. W. Rosenhain and Mr A. C Sturney, contains an account of experiments made to determine the behaviour of material in the vicinity of the edge of the cutting tool, and is illustrated with several unique photomicrographs of cross sections taken through chips in process of formation. By using a simple type of cut and varying only two factors, namely, depth of cut and top-rake angle, certain definite regularities of behaviour have become manifest. According to the conditions of cutting, the separated metal takes the form of three distinct types of chip: (*a*) the "tear" type, in which rupture of the metal occurs by the formation, well in advance of the nose of the tool, of a tear or crack tending to run inwards from the periphery of the stock Since such a tear cannot progress very far, a succession of fresh starts are made by the tool, and the surface of the work is left in the form of rough projections, each of which probably corresponds to successive shearing of the chip. (*b*) When the conditions are changed by either reducing the depth of cut or increasing the top-rake angle, or both, the ultimate result is the formation of the "flow" type of chip. (*c*) Intermediate conditions produce an intermediate type called the "shear" type, since it is formed mainly by a process of shearing on a plane making an angle of roughly 30° with the direction of motion of the tool. So far as the present investigation goes, it indicates that the best results in cutting in regard to the removal of the maximum amount of metal per unit distance of tool travel, the least irregularity of surface, the closest agreement between intended and actual depth of cut, and the minimum wear of tool, are obtained by using a top-rake angle a very little smaller than that at which the heavily deformed zone before the nose of the tool just disappears, in conjunction with the greatest depth of cut which still allows the formation of the flow type of chip.

The Future of the Motor Ship.

By Engineer-Capt. EDGAR C SMITH, O.B.E., R.N.

THE introduction of the "Otto" cycle for gas-engines by Nicolas August Otto in 1876, the construction of the compact light spirit engine by Gottlieb Daimler in 1884, and the publication of his memoir, "The Theory and Construction of a Rational Heat Motor," by Rudolf Diesel in 1893, are three of the landmarks in the history of the internal combustion engine. The first led to a great extension in the use of gas-engines, the second paved the way for the motor car and aeroplane engine, while Diesel's work gave us the most efficient of modern heat engines. Just as the petrol engine has revolutionised transport by road, so the Diesel engine bids fair to revolutionise transport by sea. Otto died in 1891, Daimler in 1900, and Diesel was drowned in the North Sea in 1913, but each lived long enough to see his work bearing good fruit.

Diesel, who was born in Paris of German parents in 1858, was induced to take up the study of thermodynamics by von Linde, and ultimately assisted Linde in his work on refrigerators. He also worked in the shops of the well-known firm of Sulzer Brothers of Winterthur, and after completing his theoretical investigations was enabled to build an experimental engine. Many interesting details of his early work were given by Diesel himself to the Institution of Mechanical Engineers in 1912, but it was his account of a 20 H.P. engine communicated in 1897, which first attracted general attention, and it was then that, upon the advice of Lord Kelvin, a Scottish firm of engineers took up the manufacture of Diesel engines. Though, like the steam turbine of Sir Charles Parsons, it found its first useful sphere in the power-houses of the day, its application to ships was only a matter of time, and after being used in various craft, a Diesel engine was fitted in the *Toiler* by the Tyne firm of Swan, Hunter, and Wigham Richardson, and in 1911 that vessel crossed the Atlantic.

The *Toiler* was but a small vessel of 3000 tons carrying capacity and 360 horse power, but she was soon followed by the *Jutlandia* and *Selandia*, engined by Burmeister and Wain of Copenhagen, and then by the British vessels *Arum*, *Arabis*, and *Abelia*, all three of which were the victims of German submarines during the War. At the beginning of the War in 1914 there were nearly three hundred Diesel-engined ships afloat. The War, however, hindered progress in this direction, but during the last year or two much greater strides have been taken, and there are now nearly 2000 motor ships of a total tonnage of 2,000,000 tons, and about half the ships under construction to-day are designed for driving by Diesel engines. It is true this 2,000,000 tons is but about a thirtieth of the world's tonnage, but the facts are significant, and many consider that what the Americans have called the "Dieselisation of the sea" has definitely set in.

How the steam reciprocating engine and the steam turbine are being displaced can be seen from the following figures, gleaned from the returns of Lloyd's Registry of shipping, which show the tonnage classed each year and the types of machinery adopted.

Year	Steam Reciprocating Engine	Steam Turbine	Oil-engine
	Tons.	Tons.	Tons.
1918–19	2,633,570	1,051,302	75,934
1919–20	2,821,031	1,286,046	79,805
1920–21	2,373,067	754,513	101,608
1921–22	1,420,524	870,037	226,552
1922–23	842,358	603,037	165,229
1923–24	610,851	99,464	164,336

In view of these facts, especial interest attaches to the presidential address of Sir Westcott S. Abell, the chief ship surveyor of Lloyd's Registry, to the Institute of Marine Engineers, delivered on February 10, and to the lecture of Sir Fortescue Flannery to the Royal Society of Arts on the following day. "The Motor Ship in the Light of the History of Marine Propulsion" was the title of Sir Westcott Abell's address, while Sir Fortescue Flannery took as his subject "The Diesel Engine in Navigation." So firmly convinced are both authors that the Diesel engine is the ships' engine of the future, that the former remarked that "the disappearance of the steam-engine from overseas trade is largely a matter of time," while Sir Fortescue Flannery said that an examination of the figures "gives support to the belief that in a comparatively short time the Diesel engine will almost wholly displace the steam boiler at sea."

Though both containing the same conclusions, the two addresses were very different in character. Starting with the point of view that the Diesel engine has demonstrated its reliability—an essential feature in any marine engine—Sir Westcott Abell discussed what he termed the economic efficiency of the motor ship. At present, Diesel engines cost much more than steam machinery, and the cost of the oil per ton is enormously greater than the cost of coal per ton. But the reduction in the amount of fuel expended is so great that "with the present availability of and cost of oil fuel there is a distinct margin in profit in favour of the Diesel-engined ship compared with the coal-fired boiler and the steam-engined vessel." Sir Westcott's figures and diagrams illustrate this point, for with a ship of 8000 tons deadweight carrying capacity, the oil-engined ship can carry 10 per cent more cargo than the steamship. Discussing the mechanical and thermal efficiencies possible with modern machinery, Sir Westcott Abell comes to the conclusion that even with the heavy Diesel engine at present fitted, where only 5 B.H.P. is obtained for every ton of machinery, "the principal economic gain arising from the introduction of the Diesel engine has already been obtained." The problem now is "to devote considerable attention to obtaining the maximum simplicity, gaining thereby in reliability and ease of maintenance." Also, there are the auxiliaries, in which many improvements can be made. Among the diagrams illustrating the address is one showing the decline of the sailing-ship and the rise of the steamship, and it will be interesting to see if the Diesel engine supersedes the steamship in the same way.

The crowded lecture-room of the Royal Society of Arts and the gathering of distinguished shipowners, shipbuilders, and engineers on the occasion of Sir Fortescue Flannery's lecture were ample testimony to the importance of the subject. The interest of the occasion was increased by the presence in the chair of Lord Bearsted, the pioneer of the present-day system of carriage of petroleum in bulk in tank steamers. The lecture was a review of the introduction of the use of oil and the action of the Diesel engine, and contained explanations of the types of Diesel engines, of which there is a somewhat bewildering variety. Compared with a good steam plant, which uses about 1·8 lb. of coal or 1·4 lb. of oil per B.H.P. per hour, the Diesel engine burns about 0·4 lb. Apart from the saving in the fuel bill, a Diesel-engined ship can go farther afield or more cargo can be carried. All early motor ships had twin screws, but experience has shown the oil engine to be reliable and single screws are now being fitted where suitable. Sir

Fortescue Flannery dealt with the main points in the different designs of single-acting and double-acting, and of four-stroke and two-stroke engines such as the Burmeister and Wain, North British, Tosi, Vickers, Werkspoor, Doxford, Fullagar, Polar, and Sulzer, and also of that most interesting development, the Still engine, which is a Diesel engine and steam-engine combined. Developments are still proceeding with rapid strides towards the double-acting type and the consequent increase of power in proportion to the weight, but there is at present no approach to the standardisation such as is attained in the triple-expansion engine.

During the course of the evening, Lord Bearsted read a characteristic letter on the oil question from the late Lord Fisher, written in 1911, and he also gave some figures respecting the oil-engines suitable for a light cruiser. The cruiser, it is true, would have a speed of 26 knots as against a speed of 28 knots of her sister ship with steam machinery, but she would have a very much greater radius of action He seemed to think that the Admiralty has not done so much as it might to further the progress of the oil-engine for propulsion

In the discussion that followed, Engineer Admiral Sir Robert Dixon, the Engineer-in-Chief of the Fleet, recalled the work done in the Navy on the Diesel engines for submarines and referred to the experimental plant founded at West Drayton. Before an oil-engined battleship is feasible, however, the Diesel engine must give far more power for its weight than those in existence at present

It may be remarked that even the late Lord Fisher would scarcely have cared to command a light cruiser of 26 knots, even if fitted with oil-engines, when trying to overtake an enemy ship of the same class wth a speed of 28 knots In building the famous *Dreadnought*, a thousand tons in weight and 100,000*l.* in money were saved by the adoption of steam-turbine machinery, but there seems little prospect at present of doing anything similar by the adoption of Diesel engines in a man-of-war

The Effects of Posture and Rest in Muscular Work.[1]

THE problems of muscular activity have been investigated for many years from an academic viewpoint, yet it is only in recent times that a demand has arisen for the application of exact means of measurements of the physiological cost of muscular work in industry The Medical Research Council's report for the years 1923-24 states that "The studies of muscle function which were almost notorious for their supposed uselessness to the student or physician have laid down basic knowledge which now underlies many parts of medical science and art, and are beginning to remove empiricism from practical studies of physical training and of industrial labour"

The output of energy of an individual may be calculated by measuring the amount of oxygen and carbon dioxide present in the expired air, and from these data the physiological cost of the work can be assessed This method of estimating the "cost" of work or muscular activity places at our disposal a means of comparing the efficiency and capacity of the human machines under different conditions.

Two methods are available for the measurement of energy output—(*a*) direct and (*b*) indirect calorimetry The unit of measurement used is the large or kilo calory. In direct calorimetry the individual is enclosed in a special chamber so constructed that the heat given off is measured The apparatus is also arranged for the collection of the expired air, so that direct and indirect calorimetry may be combined

In indirect calorimetry the subject wears a mouth-piece fitted with two valves One valve serves for inspiration, while the other valve allows the expired air to pass down through a wide tube into a rubber bag, which the subject carries during the experiment The expired air can be drawn off and analysed in a Haldane apparatus. The ratio of carbon dioxide given off to oxygen absorbed can then be obtained, and from these data the heat units are calculated. If the measurements are carried out on the subject at rest and during work, an exact estimation can be made of the energy required for this particular task.

In a recent publication of the Industrial Fatigue Research Board on "The Effects of Posture and Rest in Muscular Work," Miss E. M. Bedale has investigated the energy expenditure of a woman carrying loads in different positions. Miss Bedale has used the indirect calorimetric method for estimating the physiological costs of the work. It is shown from the measurements made that the energy expenditure varies with the position in which the load is carried. The physiological cost of carrying with a yoke is low and involves less physiological disturbance than any other The experiments suggest that the continuous carrying of a load exceeding 35 per cent. of the body-weight is likely to cause rapid impairment of working capacity A series of photographs of the different modes of weight-carrying bring out the importance of the study of body posture. Some of the methods, if used continually, will rapidly lead to body deformities, with impairment of the normal physiological functions The use in industries of methods least injurious to the body would be an aid in the prevention of disease, and undoubtedly lead to greater efficiency The results of further investigations will be awaited with interest The data collected will tend to remove empiricism from studies of industrial labour, and will give a standard of measurement more accurate than that of output

Prof. E P Cathcart contributes a preface which deals in a clear and concise manner with methods of measurement, and points out the pitfalls which beset the investigator in work of this type

In the same publication, Dr H M Vernon gives the results of an investigation on "The Influences of Rest Pauses and Changes of Posture in the Capacity for Muscular Work" The conclusions drawn by Dr. Vernon suggest that the promotion of circulation plays an important part in the prevention of fatigue, the value of a rest pause being increased if the worker moves about during the interval. Postural changes during work are shown to be as necessary as rest pauses if efficient work is to be carried out

An interesting point is raised concerning the effect of additional movements during muscular work. The application of motion study to industrial processes has resulted in the elimination of many unnecessary movements and a marked increase in output The results now obtained suggest that the removal of too many unnecessary movements may be too drastic, and even better results might be obtained if a few extra movements, sufficient to promote circulation, were allowed. The proof of this suggestion will probably only be obtained by investigating each process separately by the old method of trial and error

[1] Medical Research Council: Industrial Fatigue Research Board. Report No. 29: "The Effects of Posture and Rest in Muscular Work: (*a*) Comparison of the Energy Expenditure of a Woman carrying Loads in Eight Different Positions," by E. M. Bedale; (*b*) "The Influence of Rest Pauses and Changes of Posture on the Capacity for Muscular Work," by Dr. H. M. Vernon. Pp. 35. (London: H.M. Stationery Office, 1924.) 2*s.* 6*d.* net.

University and Educational Intelligence.

BRISTOL.—Last year the Council set aside a portion of a bequest from the late Mr. H. H Wills for the purpose of providing additional staff and equipment in the Department of Physics when the erection of the Henry Herbert Wills Physics Laboratory is completed. Though the building is not yet ready for occupation, it has been decided to create a readership in mathematical physics as from August 1, and Dr. J. E. Jones has been appointed the first reader.

CAMBRIDGE —Mr. Ll. H. Thomas, Trinity College, and Mr H. Horrocks, St Catherine's College, have been elected to Isaac Newton Studentships in astronomy and physical optics.

EDINBURGH —At the meeting of the University Court on Monday, February 16, a letter was read from Sir Richard Lodge intimating his resignation from the chair of history as from the end of the current academical year. The Principal expressed great regret on behalf of the Court In Sir Richard Lodge the University had an ornament of whom it was proud and an invaluable helper in every branch of University activity His departure would be a severe loss not only to the School of History, which owed its present high reputation to his unremitting efforts, but also to the whole University, to the interests of which he had devoted his great abilities during a period of more than twenty-five years

Mr W. Oliver was appointed to be the first occupant of the chair of the organisation of industry and commerce, which was founded by a recent Ordinance of the University Court.

It was intimated that the Senatus had unanimously resolved, on the recommendation of the Faculty of Medicine, to award the Cameron Prize for the year 1925 to Prof R. Magnus, the Royal University, Utrecht, Holland This prize, of the value of about 200*l*., is awarded annually to a person who in the course of the five years immediately preceding has made a highly important and valuable addition to practical therapeutics.

The resignation, as from September 30, of Mr W. L Ferrar, lecturer in mathematics, on his election to a tutorial fellowship at Hertford College, Oxford, was accepted.

LEEDS —Dr. T. Wardrop Griffith has placed before the Council of the University his resignation of the professorship of medicine

Prof. T Wardrop Griffith was appointed to the chair of anatomy in 1887 and transferred to the chair of medicine in 1910 He began work in the old Medical School in Park Street and took an active share in the construction of the new School in Thoresby Place, in which he established one of the best anatomical departments in Great Britain.

OXFORD.—There will be an election at Keble College on March 16, on the results of an examination, to a Natural Science Scholarship on the Gibbs Foundation, of the value of 80*l*. per annum. Candidates must be more than twenty years of age on March 16, and if already members of the University, of not more than two terms of University standing on that day. By the terms of the benefaction, the scholarship is tenable only by members of the Church of England. Inquiries should be addressed to Mr. G. D. Parkes, at Keble College, on or before March 2.

SHEFFIELD —Applications are invited for the chair of mining They should be sent to reach the registrar by, at latest, March 31.

DR. W. HIEBER, of Würzburg, has been appointed director of the department of inorganic chemistry at the University of Jena.

A NUMBER of scholarships in connexion with Bedford College for Women, Regent's Park, N.W.1, are being offered, particulars of which are obtainable from the principal.

APPLICATIONS are invited for two posts at Auckland University College, New Zealand, namely the professorship of forestry and a lectureship in civil engineering. Particulars may be had from the High Commissioner for New Zealand, 415 Strand, W.C.2.

THE Leathersellers' Company's Technical College, 176 Tower Bridge Road, S.E.1, invites applications for the post of chemical lecturer and demonstrator. Candidates must possess a good science degree, but a knowledge of leather is not essential.

THE annual general meeting of the Association of Technical Institutions will be held at the Institution of Mechanical Engineers, Storey's Gate, London, on Friday and Saturday, March 6 and 7. The proceedings will commence with a reception by the acting president, Mr. W. H Patchell, which will be followed by the presidential address of the president elect, the Right Hon. Lord Montagu of Beaulieu. Friday afternoon and Saturday morning will be devoted to the consideration of business matters and the reading of papers by The Right Hon Lord Emmot and Principal W. M. Varley, on "The Local College and its relation to surrounding Education Authorities", Mr. G. Mavor, Head of the Department of Continuative Education, Loughborough College, on "Training and Education for Apprenticeship", Mr. J. E Montgomrey, assistant secretary of the Institution of Mechancial Engineers, on "The Working of the Schemes for National Certificates and Diplomas in Engineering" Sir John Dewrance is entertaining members of the Association and others attending the meeting to luncheon on Friday, March 6, at the Trocadero Restaurant.

THE Royal Technical College, Glasgow, has received a gift of 50,000*l*. from an anonymous donor, who has given the governors of the College complete freedom to expend the revenue derived from it as they may see fit. The industrial depression in the south-west of Scotland, particularly severe in the engineering, shipbuilding, and iron and steel industries, with which the College is closely associated, has resulted not only in a diminution in the number of local students, although it has still double the number of the regular students of session 1913–14, but also there has been less capacity on the part of the industries to give financial support to the College. There is little doubt that the wise and far-seeing policy of the late Sir George Beilby, who was chairman of the governors for many years and the guiding spirit in the remarkable development of the College, both in its teaching organisation and the provision made for research work, has led the anonymous donor to consider the College worthy of this most welcome addition to its resources. Sir George Beilby's connexion with the College is to be marked by the foundation of a memorial medal in technical chemistry and by the generous gift by Lady Beilby of his excellent organ, which is to be reconstructed and placed in the College hall. Other recent donations are the continuance by the Bellahouston Trustees for another three years of an annual grant of 1000*l*. which they have given during the past five years, and substantial additions to the electrical engineering equipment in the form of modern machines presented by about twenty leading British firms of electrical engineers.

Early Science at Oxford.

February 29, 1683/4. Dr. Wallis was pleased to inform us, that ye way commonly used in opening frozen pumps, with salt, has been known to make pumpwater, under his house, apt to curdle in boiling, and unfit for washing, which naturally is fit for use, and bears soap very well; but ye water probably will recover itself as soon as ye salt shall be drawn off.

Dr. Pit acquainted ye Society, that sallet oyl cannot be made to boyl over; this has been observed by late experiments, and will give some light to that custom of ye sugar boilers, who used to throw a piece of sewet, candle, etc into their sugar; and by these means keep it from boiling over

Some Queries concerning the splitting of Trees by ye late great frost, were brought in by Dr. Plot. they are as follows:—Whether any of these trees have split with a noise? Whether they are split quite through, or only on one side? Whether they are all split to ye same point of ye Compass? Whether ye splitting be more common in ye Trunk, or in ye Boughs? Whether any Ice has been found in ye vessels of ye wood? Whether ye trees split be any of them dead? Whether any of ye trees split have closed since ye thaw? Whether ye Bark be loosned by ye splitting, from ye wood?

Dr. Wallis mentioned vast numbers of dead Congers, which were thrown up by ye sea, at Dim-Church wall, along ye coast of Kent, during the late hard frost, as also about eight years ago, the same was observd on ye Severn shore in Somersetshire, about twenty years ago

March 1, 1686/7. Upon mentioning of Mr. Hooke's Discourse about the changes which he supposes to have been made upon the surface of the Earth, Mr President observed that the latitude of Oxford is not sensibly altered in these four hundred or five hundred years last past, as appears by the Alphonsine Tables and some MSS. in Oxford, in which though there may be about one minute more, or one minute less than ye present latitude, yet that may well be attributed to the unaccurateness of the observations. —It was stated at this meeting that the age of one Mother George, now living in Oxford, is about one hundred and eleven years.

March 2, 1685/6. Dr. Plot shewed ye Society two Swedish Runestocks or Primestocks, and one book almanack; also severall old English almanacks, of which some were for families, others for private persons; some of brasse, others of wood, all perpetuall.

March 3, 1684/5. Mr. Leigh gave a farther account of ye Balsamic Earth It will take fire at a candle, and, if tost in ye air, will burn exactly like a torche, an oyl dropping from it scarce distinguishable from ye oyl of amber Any other earth whatsoever, if put into ye place, where this is dug, will in a year's time be exactly the same with this. 4 drops of this oyl is a present Cure for ye Colic, and may therefore in all probability be proper in those distempers, which affect the nerves

A letter from Mr. John Aubrey, dated London Feb. 27, mentioned an opinion that some merchants were of; that beasts are generally offended at a Barbary Lion's skin. There being one of these skins in ye Musæum Ashmolianum, he desires, ye truth of this matter may be enquired into, which was ordered to be done.

March 6, 1687/8. An account was delivered of what appeared to Mr. Pit upon the dissection of a *dog*, that had Mercury injected into one of the jugulars. The mercury was thrown out of the blood into the cavity of the abdomen, as likewise some appearance of it in the other cavitys of the body.

Societies and Academies.

LONDON.

Royal Society, February 19.—O W **Richardson** and A. F. A **Young**: The thermionic work-functions and photoelectric thresholds of the alkali metals The photoelectric threshold for normal potassium is close to 7000 Å U, which agrees with the known wavelength of maximum activity λ_{max} and the equation $\lambda_0 = \frac{3}{2}\lambda_{max}$ Uncertain traces of a thermionic threshold agreeing with this have been found at about 200° C. in one experiment, but the thermionic thresholds usually effective at this and lower temperatures are of a much lower magnitude, even under the best vacuum conditions. A common thermionic threshold effective at about 200° C. corresponds to λ_0 = about 10,000 Å U A photoelectric emission with this infra-red threshold has been got by exposing potassium to a luminous discharge in hydrogen or water vapour This may be due to the growth of small patches normally present. There is no evidence of photoelectric activity further out in the infra-red, although there is a thermionic threshold which corresponds to $\lambda_0 = 30{,}000$ A U The glow discharge not only brings out undeveloped thresholds, but it also augments the normal emission.—J H **Brinkworth** On the measurement of the ratio of the specific heats using small volumes of gas The quantity actually measured is the cooling effect in adiabatic expansion, *i.e.* the ratio of the drop in temperature to the drop in pressure These two quantities are measured directly, the former by using a suitable platinum thermometer, and the latter from the readings on an oil gauge The values of the ratio of the specific heats thus experimentally obtained are used for the calculation of the specific heats of air and of hydrogen The specific heat of air at constant pressure is practically constant, and equal to 0·2395 cal /gm °C over the temperature range 155° to 290° A The molecular heat of hydrogen falls rapidly from 4·88 at 290° A. to 3·30 at 90° A None of the theoretical curves representing the variation in the molecular heat of hydrogen agrees with the experimental curve, the divergence, at some temperatures, being certainly five times greater than an outside estimate of the inaccuracy of the experimental results.—F H **Constable**: The catalytic action of copper. Part VI Chemical reaction occurs only when an alcohol molecule is adsorbed over a characteristic arrangement of copper atoms, called a reaction centre. There is a large variation in the number of atom centres lying beneath one adsorbed alcohol molecule on various crystal faces thus the reaction centre density varies also. The activity of the surface is controlled by the exponential activation factor, and by the reaction centre density on the surface.—Part VII The rate of dehydrogenation of ethyl and butyl alcohols has been studied at pressures from 10 cm of mercury to two atmospheres. The reaction velocity was found to be independent of the pressure.—V. H **Stott**, Edith **Irvine**, and D. **Turner**: Viscosity measurements with glass. For the range 10^8 to 10^{17} poises, the apparatus is a modification of the method of Trouton and Andrews, in which the resistance to torsion of a circular rod is determined This apparatus may be readily modified so as to extend its applicability down to 10^4 poises. Measurements of lower viscosities down to about 10^2 poises depend on determinations of the rate of fall through the glass of a partially counterpoised iridio-platinum ball. Temperature uniformity in the latter case has been achieved by the use of an electrically heated "black body" furnace possessing novel features.—W. G. **Palmer** and F. H.

Constable: The catalytic action of copper, Part V. The reaction velocity-temperature curves for ethyl, *n*-propyl, butyl, *iso*butyl and *iso*amyl alcohols (which have in common the grouping $-CH_2OH$) are identical within the limits of experimental error. This identity involves also the equality of the temperature coefficients and of the heats of activation. The higher alcohols caused rapid "poisoning" of the catalyst, but this secondary effect was circumvented.—P. A. M. **Dirac**: The adiabatic invariance of the quantum integrals. The postulate of the existence of stationary states in multiply periodic dynamical systems requires that if the condition of such a system, when quantised, is changed in any way by the application of an external field, or by the alteration of one of the internal constraints, the new state of the system must also be correctly quantised. It follows that the laws of classical mechanics cannot in general be true, even approximately, during the transition. During the so-called adiabatic change, which takes place infinitely slowly and regularly, so that the system practically remains multiply periodic all the time, classical laws may be expected to hold. In this case the quantum numbers cannot change, and it has been possible to deduce from the classical laws that the quantum integrals remain invariant.—D. L. **Watson**: The thermal decomposition of derivatives of oxalacetic ester: a unimolecular reaction. The decomposition, on heating, of derivatives of oxalacetic ester into a malonic ester derivative and carbon monoxide obeys the unimolecular (or simple probability) law, $dx/dt = k(a - x)$, and the velocity is uninfluenced by diluting with solvents or adding acidic substances, though retarded by high concentration of carbon monoxide. None of the substances could be stimulated to react by light of wave-length predicted from the Lewis-Perrin theory, or by ultra-violet radiation, which they absorb very strongly. They had energies of activation between 33,000 and 36,000 calories, and an "active life" of the order of 10^{-14} second, in agreement with many other first-order changes. The velocity of decomposition of phenyl-oxalacetic ester, however, was proportional to the amount of phenyl-malonic ester formed by the change (except when the latter substance was present in excess). This law, characteristic of simple reactions in pure liquids, may be explained by the hypothesis of "reflex activation," namely, that highly energised products of reaction are largely responsible for formation of fresh "active" molecules. Here, as in all known unimolecular reactions, two species of molecules evidently take part in the change.—K. R. **Rao**: (1) On the fluorescence and channelled absorption of bismuth at high temperatures. The absorption spectrum has been photographed at temperatures of the order of 1500° C. Some of the absorption bands in the visible region exhibit distinctly a fine structure, showing that these are due to the triple quantification. The vapour emitted a fluorescent radiation, and the fluorescent banded spectrum ranging from λ6570-λ5040, containing about 20 bands, shaded towards the red, has been photographed. This banded fluorescent spectrum indicates probably that the critical potentials of elements which are polyatomic are related to the molecule and not to the atom.—(2) A note on the absorption of the green line of thallium vapour. The green line of thallium consists of an intense central doublet accompanied by two satellites. Absorption by a column of non-luminous vapour indicates complete absorption of the central doublet at about 800° C., at which temperature the satellite was but very feebly absorbed. The total absorption of the satellite took place at about 950° C.—B. F. J. **Schonland**: The passage of cathode rays through matter. Cathode rays of velocities up to 0·55 that of light (100,000 volts) in quantities easily measurable on a galvanometer, were produced. These rays have been used to extend measurements of cathode-ray absorption to the β-ray region. The difference in variation of apparent absorption with velocity for different elements depends upon the fact that this is not a true absorption, since it includes the effect of the scattering back of rays on the side of incidence. The existence of a range for these rays has been established, and the values found for ranges at various velocities in aluminium are in close agreement with those calculated on Bohr's theory of absorption, which has now been tested from $\beta = 0{\cdot}20$ to $\beta = 0{\cdot}90$, with rays of penetrating power varying in the ratio of 1 to 5000. Cathode-ray absorption is due to gradual loss of energy of moving particles by collisions with electrons in matter. An examination of the principles underlying Bohr's theory of absorption shows that interchange of energy in such collisions must take place more freely than the usual conceptions of atomic structure allow. Absorption of cathode rays of various speeds by atoms of a given element does not appear to show any discontinuities corresponding to those observed in X-ray spectra.

PARIS

Academy of Sciences, January 19.—The president announced the death of L. Maquenne, member of the section of rural economy.—Maurice **de Broglie** and Jean **Thibaud**: The exceptionally intense absorption of a radiation by the atom which has just emitted it.—Maurice **Lugeon**: Fluvial erosion. Example of the Rio Negro in Uruguay.——**Calichiopulo**: The harmonic law of distribution of the errors of observation.——**d'Ocagne**: Remarks on the preceding communication.—Enea **Bortolotti**: Extension of the Beltrami-Enneper theorem to conjugated networks from V_2 to V_3.—D. **Mordouhay-Boltovskoy**: The primary factors of the integral function.—J. **Dufay** and A. **Couder**: The photometric study of the total eclipse of the moon of August 14, 1924. This eclipse was observed in a clear sky at Saint-Geniez (Basses-Alpes, 1070 metres). At 10′ from the centre of the shadow the stellar magnitude of the moon was, in red light ($\lambda = 0{\cdot}61\mu$), −2·8 in October 1921, and −1·3 in August 1924.—J. H. **Shaxby**: The diffusion of particles in suspension. As spheres of uniform size the cocci of the pyogenes staphylococcus were utilised, suspended in water. The value of the Avogadro number deduced from the experiments was 59×10^{22}.—Beaulard **de Lenaizan** and J. **Granier**: The specific inductive capacity of ice. The value 2·17 was found for the specific inductive capacity of ice, at a temperature of −4·5° C., and with a wave-length in air of 363·2 cm.—Marcus **Brutzkus**: A new mode of production of chemical reactions.—D. K. **Yovanovitch** and J. **d'Espine**: The magnetic spectrum of the high-velocity β-rays of thorium B+C. Seven of the high-velocity β-rays measured by L. Meitner are confirmed: three additional rays have been detected for which $H\rho = 6800$, 18,000, and 40,000. These new rays are very faint.—Henry **de Laszlo**: The absorption of ultra-violet rays by the methyl derivatives of naphthalene. The absorption spectra of α- and β-methylnaphthalene, 2 6-dimethylnaphthalene and 2,7-dimethylnaphthalene were measured, and the results are given on a diagram.—P. **Vaillant**: The law of variation with temperature of the (electrical) conductivity of solid salts and its possible relations with the characteristic spectrum of the metal of the salt.—Mme. Pierre **Curie**: The estimation of radium in uranium minerals containing tantalum, niobium, and titanium. The mineral is mixed with barium sulphate, fused with

potassium bisulphate, extracted with water and filtered. The precipitate on the filter is treated with dilute hydrofluoric acid. The insoluble portion containing the radium is boiled with sodium carbonate, to convert the barium and radium into carbonates, and the latter dissolved in dilute hydrochloric acid. After concentration to ice, the emanation is removed by a current of air and estimated in the usual manner.—Mlle Suzanne **Veil**: The evolution of the hydrate of nickel sesquioxide in the presence of water.—André **Charriou**: The use, in catalysis, of alumina which has absorbed various other substances. The decomposition of ether at 250° C. in the presence of alumina was studied. With one exception, the blue oxide of tungsten, the presence of foreign substances (SO_3, P_2O_5, CuO, CaO, CoO) reduced the catalytic power of the alumina in this reaction.—G. **Dubar**: The formations of the Lias and the upper Jurassic in Asturia.—L. **Eblé** and J. **Itié**: The values of the magnetic elements at the station of Val-Joyeux (Seine-et-Oise) on January 1, 1925.—L. **Blaringhem**: The production of new hybrids between the wild species of Triticum and the principal cultivated wheats. Analysis of their affinities.—A. **Guilliermond**: The instability of forms and the permanence of the mitochondria.—P. **Delauney**: The glucosides of several species of native orchids.—Emile F. **Terroine** and Jean **Roche**: Heat production and respiration of the tissues *in vitro* in the homeotherms.—A. F. **Roffo**: The action of the Röntgen rays on cholesterol. Cholesterol, in solution, is destroyed by the action of the X-rays, but the crystallised alcohol is unchanged by this treatment.—Edouard **Chatton** and André **Lwoff**: The etiology and structure of the Spirophyra. Their relationship with the Fœttingeria. The origin and evolution of the parasitism of these infusoria.

VIENNA

Academy of Sciences, December 11.—H. **Pettersson**: Communication from the Radium Institute, No. 173. On the reflection of α-particles from atomic nuclei, α-particles were scattered through nearly 180° by five different elements. With three of these elements, which are known to be disintegrated, no reflected α-particles were observed, even at ranges considerably smaller than those calculated by the collision-theory. With two heavier elements α-rays were observed, but with much smaller ranges than would correspond to an elastic collision. Possible explanations are given on the assumption that the α-particle penetrates into the nucleus. H-particles were detected after bombarding nickel and copper with α-particles.—H. **Handel-Mazzetti**: New Chinese plants (30th communication). An index list of some 100 descriptions published during 1924 is given.—J. **Albrecht**: Palæontological and stratigraphical results of the journey of Dr. Ampferer and Dr. Hammer in Western Serbia in the year 1918.—M. **Kohn** and S. **Strassmann**: Ninth communication on bromophenols, bromo- and bromo-nitro-phenols.—M. **Kohn** and R. **Marberger**: Tenth communication on bromophenols. On chloro-nitro-ether and bromo-nitro-ether of hydroquinone and of tolu-hydroquinone and the mobility of the halogen atom in the same.—M. **Kohn** and S. **Grim**: Eleventh communication on bromophenols. Bromination of hydroquinone-monomethyl-ether and of nitro-hydroquinone-dimethyl-ether.

Official Publications Received.

New South Wales. Department of Mines: Geological Survey. Mineral Resources, No. 32: The Coal Resources of the Douglas Park Area, and Tabulated List of Coal Borns, Counties of Cumberland and Camden. By L. F. Harper. Pp. 22. (Sydney: Alfred James Kent.) 1s.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 277: Radio Acoustic Method of Position Finding in Hydrographic Surveys. By Comdr. N. H. Heck and E. A. Eckhardt and M. Keiser. (Special Publication No. 107.) Pp. iv+28. Serial No. 278. Velocity of Sound in Sea Water. By Comdr. N. H. Heck and Ensign Jerry H. Service. (Special Publication No. 108.) Pp. iii+27. (Washington: Government Printing Office.) 10 cents each.

Agricultural Progress: the Journal of the Agricultural Education Association. Vol. 2, 1925. Pp. 122. (London: Ernest Benn, Ltd.) 5s. net.

British Association for the Advancement of Science. Report of the Conference of Delegates of Corresponding Societies, 1924, including List of Papers bearing upon the Zoology, Botany and Prehistoric Archæology of the British Isles. By T. Sheppard. Pp. 489-554. (London: British Association, Burlington House, W.1.)

The Carnegie Trust for the Universities of Scotland. Twenty-third Annual Report (for the Year 1923-24) submitted by the Executive Committee to the Trustees on 11th February 1925. Pp. iv+77. (Edinburgh: The Merchants' Hall.)

Bulletin of the American Museum of Natural History. Vol. 47, Art. 7. Primates collected by the American Museum Congo Expedition. By J. A. Allen. Pp. 283-499+plates 79-167. (New York City.)

The Indian Forest Records. Vol. 10, Part 11. Burma Oak and Chestnut Tans, being the Report of an Investigation from the Tannin standpoint of the different parts of the various Oak and Chestnut Trees, principally those species growing in the Maymyo and Kalaw Areas. By J. A. Pilgrim. Pp. vi+90. (Calcutta: Government of India Central Publication Branch.) 1.1 *rupees*, 1s. 6d.

Nigeria. Third Annual Bulletin of the Agricultural Department, 1st July 1924. Pp. 96. (Lagos.) 5s.

Memoirs of the Colombo Museum. Edited by Dr. Joseph Pearson. Series A, No. 3: Ceylon Coins and Currency. By H. W. Codrington. Pp. viii+290+7 plates. (Colombo.) 10 rupees.

Publikation der Sternwarte in Kiel. 18. Berechnung der Ablenkungen der Lichtstrahlen in der Atmosphäre der Erde auf rein meteorologisch-physikalischer Grundlage. Von Paul Harzer. Pp. 89. 14 Gebrauchstabellen zur Berechnung der Ablenkungen der Lichtstrahlen in der Atmosphäre der Erde für die Beobachtungen am grossen Kieler Meridiankreise. Von Paul Harzer. Pp. 23. (Kiel: C. Schaidt.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 495: A Radiometric Investigation of the Germicidal Action of Ultra-violet Radiation. By W. W. Coblentz and H. B. Fulton. Pp. 629-680. (Washington: Government Printing Office.) 20 cents.

Annual Report of the Director, United States Coast and Geodetic Survey, to the Secretary of Commerce, for the Year ended June 30, 1924. Pp. iv+80+21 plates. (Washington: Government Printing Office.) 10 cents.

Diary of Societies.

SATURDAY, FEBRUARY 28

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (1.)

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—E. S. Rayner: Road Passenger Transport.

MONDAY, MARCH 2

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—R. I. Money: *Notes on Preparing a Tender*.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 5.30.—Dr. H. E. Meleney: Kala Azar in China, with special reference to its Histo-pathology in Experimentally Infected Hamsters.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 6.—L. Breach and H. Midgley: Drive of Power Station Auxiliaries.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London) (Annual Lecture), at 7.—W. H. Patchell: A Visit to America.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—J. H. Harley: The Theory of the State.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (III.) (Cantor Lectures).

SOCIETY OF CHEMICAL INDUSTRY (London Section, jointly with the Institute of Chemistry (London Section)) (at Chemical Society), at 8.

INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club, Coventry Street, W.), at 8.—F. Jones: Standardised Rubber-ware.

ROYAL SOCIETY OF MEDICINE (Epidemiology, Comparative Medicine, and Disease in Children Sections), at 8.—G. P. Male, Dr. M. J. Rowlands, Dr. Stanhouse Williams, Dr. David Nabarro, Sir Layton Bienkinsop, and others: Special Discussion: The Control of Tuberculosis and the Milk Supply.

INSTITUTE OF CHEMISTRY (Manchester Section).—Dr. A. Renshaw: Chemical Poisoning occurring amongst Industrial Workers.

TUESDAY, MARCH 3

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (IV.). The Colour of Fish.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—E. Banks: Variation in the Colours of European Birds in relation to the Conditions under which they live.—O. Thomas, M. A. C. Hinton, and Capt. G. C. Shortridge: On Mammals collected in 1923 by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to South-West Africa. With Field-notes by the Collector.—Dr. C. F. Sonntag: A Monograph of *Oxyuropus ater*. I. Anatomy except the Nervous System, Skin, and Skeleton.—Mary L. Hett: A New Species of Temnocephala (Trematoda) from West Australia.—V. S. Vinogradov: The Structure of the External

Genitalia in the Rodents Dipodidæ and Zapodidæ as a Classificatory Character.—A. Loveridge: Notes on East African Scorpions and Solifugæ.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. W. L. Nicol: Fuel Economy.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough Technical College), at 6.45.—R. C. Clinker: The Constants of an Electric Circuit.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Major E. I. David: Electricity in Mines.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—J. H. Russell: Slags and Fluxes, their Composition and Uses.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.15.

INSTITUTE OF METALS (North-East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—A. G. Lobley: Electric Furnaces.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—Dr. W. M. Cramp: Pneumatic Transport of Materials.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—Dr. L. A. Levy and D. W. West: The Photometry of Fluorescent Screens.

WEDNESDAY, MARCH 4.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology, Epidemiology, Medicine, Therapeutics and Pharmacology Sections), at 5.30.—Dr. W. Edgecombe, Dr. J. A. Glover, Sir William Willcox, Dr. P. Hamill, Dr. Ackerley, Dr. Middleton, Dr. Kerr Pringle, Sir Percy Bassett Smith, Dr. R. Hill, J. E. R. McDonagh, Dr. Oliver Heath, Dr. C. E. Sundell, and Dr. Higgins: Special Discussion on The Nature, Prevention, and Treatment of Fibrositis.

THE NEWCOMEN SOCIETY (for the Study of the History of Engineering and Technology) (in Prince Henry's Room, 17 Fleet Street, E.C.), at 5.30.—C. E. Greene: Gun Handicraft.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—D. Dye: Current Transformer Methods of Producing Small Known Voltages and Currents at Radio Frequencies for Calibrating Purposes.—Lieut.-Col. K. E. Edgworth and Lieut. G. W. N. Cobbold: The Measurement of Frequency and Allied Quantities in Wireless Telegraphy.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—H. W. Bannister: Water Softening in relation to Heating and Domestic Hot Water Supplies.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. Van B. Gilmour: A New Method for the Determination of Butter Fat.—R. C. Frederick: The Investigation of Ventilation Conditions.—R. C. Frederick and E. R. Webster: A Simple and Self-contained Spectroscope Lighting Unit.—P. K. Frohlich: The Carbon Error in the Quantitative Deposition of Nickel and Iron from Complex Oxalate Electrolytes.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. E. S. Turner: The Modern Production of Sheet Glass.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

MEDICAL SOCIETY OF LONDON, at 9.—Sir Bernard Spilsbury: Wounds and other Injuries (II.) (Lettsomian Lectures).

THURSDAY, MARCH 5.

ROYAL SOCIETY, at 4.30.—Sir Arthur Schuster: The Life Statistics of Fellows of the Royal Society.—Prof. G. I. Taylor and Miss C. F. Elam: The *Plastic Extension and Fracture of Aluminium Crystals*.—A. Fage: An Experimental Study of the Vibrations in the Blades and Shaft of an Airscrew.—J. H. Vincent and A. L. Beak: Experiments on the Effects of Resistance in the Oscillating Circuit of a Triode.—*To be read in title only*.—Prof. G. H. Hardy: The Lattice Points of a Circle.—Prof. H. M. Macdonald: The Transmission of Electric Waves around the Earth's Surface.—R. M. Wilmotte: The Field of Force near the Neutral Point produced by Two Equal Coaxial Coils with special reference to the Campbell Standard of Mutual Inductance.—W. R. Dean: The *Theory of Elastic Stability*.—R. A. Frazer: *The Motion of Circular Cylinders in a Viscous Fluid*.

LINNEAN SOCIETY OF LONDON, at 5.—G. C. Robson: (*a*) Seriation and Symmetry in the Cephalopoda; (*b*) Exhibition of *Opisthoteuthis depressa* (Mollusca).—K. H. Barnard: Revision of the Family Anthuridæ (Isopoda) with Remarks on certain Morphological Peculiarities.—C. C. Lucatta: (*a*) Some Critical Species of Marrubium and Ballota; (*b*) Two Rare Spanish Species of Echium.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. MacNalty: *Epidemic Diseases of the Central Nervous System* (Milroy Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir Arthur Smith Woodward: Dinosaurs.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Lt.-Col. C. B. Heald: Some Medical Aspects of Air Transport.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology, Epidemiology, Medicine, Therapeutics and Pharmacology Sections), at 5.30.—Dr. W. Edgecombe, Dr. J. A. Glover, Sir William Willcox, Dr. P. Hamill, Dr. Ackerley, Dr. Middleton, Dr. Kerr Pringle, Sir Percy Bassett-Smith, Dr. R. Hill, J. E. R. McDonagh, Dr. Oliver Heath, Dr. C. E. Sundell, and Dr. Higgins: Special Discussion on The Nature, Prevention, and Treatment of Fibrositis.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. C. Richards: Art in the Schools.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Col. T. F. Purves: The Post Office and Automatic Telephones.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—M. W. Jones: Paint and Paint Making (Chairman's Address).

CHEMICAL SOCIETY, at 8.—I. J. Faulkner and Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XVII. The Mutarotation of Aluminium Benzoylcamphor.—Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XVIII. The Mechanism of Mutarotation, and of Hydrolytic and Prototropic Change; with a criticism of Baker, Ingold, and Thorpe's Doctrine of Non-intervention.—Prof. T. M. Lowry and E. M. Richards: Studies of Dynamic Isomerism. Part XIX. Experiments on the Arrest of Mutarotation in Tetramethylglucose.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. J. S. Fairbairn and Dr. Z. Mennell: Toxæmia in Early Pregnancy with Jaundice, Hyperemesis and Multiple Neuritis.—E. Williams and Dr. R. Reynolds: A New Method of Determining the Patency of the Fallopian Tubes by means of X-rays.—Dr. S. Forsdike: Investigation of the Uterus and Fallopian Tube by Inflation with Air and X-rays.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—Prof. F. G. Donnan: Colloids.

FRIDAY, MARCH 6.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Institution of Mechanical Engineers), at 11 A.M.—Lord Montagu of Beaulieu: Presidential Address.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Henry Sharp: The Development of Indian Universities.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Prof. S. Chapman: Magnetic Phenomena in Polar Regions.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—C. T. Onions: Dictionary Evening.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section, jointly with the Liverpool Section) (at 16 Mary's Parsonage, Manchester), at 7.—Dr. A. Schædler: Chemical Constitution and Properties of Azo Dyestuffs.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Pitfalls for Patentees.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Swansea Technical College), at 7.30.—E. A. Tyler: Fine Chemicals.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. F. Etchells: How to apply for a Job and how not to do it.

INSTITUTE OF METALS (Sheffield Section) (at Sheffield University), at 7.30.—J. A. Lee: The Evolution of the Furnace.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—Debate: Industrial System, English, opened by K. Porter and J. Matheson, *versus* American, opened by T. W. Worth and H. McIvor.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Arthur Keith: Concerning the Rate of Man's Evolution.

SATURDAY, MARCH 7.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Institution of Mechanical Engineers), at 11 A.M.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford, The Counting of the Atoms (II.).

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—Dr. F. W. Crossley-Holland: Science and the Criminal.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Ancient *Mariners of the Pacific*.

MONDAY, MARCH 2.

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL, at 5.—Prof. B. P. Watson: Puerperal Sepsis (I.) (Succeeding Lectures on March 3, 4, 5.)

LEEDS UNIVERSITY, at 5.15.—R. E. Priestley: The Glacial Cycle as illustrated by Antarctica.

UNIVERSITY COLLEGE, at 5.30.—P. Fleming: The Story of Regent's Park and Regent Street.

TUESDAY, MARCH 3.

KING'S COLLEGE, at 3.30.—Rev. R. Hanson: *The Philosophy of Religion* (VI.) Is there an *a priori* Religious Judgment?

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—Prof. C. A. Edwards: Chemical Combination in Metallic Alloys and its Nature (I.). (Succeeding Lectures on March 4, 10, 11.)

UNIVERSITY COLLEGE, at 5.30.—W. J. Perry: The Spread of Culture.

LEEDS UNIVERSITY, at 8.—Prof. W. Garstang: The Terrestrial Zoology of Yorkshire.

WEDNESDAY, MARCH 4.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—F. Pick: The Principles of Design as applied to our Cities and Towns.

SCHOOL OF ORIENTAL STUDIES, at 5.15.—E. Richmond: Early Moslem Architecture. Fâtimid Architecture in Egypt.

KING'S COLLEGE, at 5.30.—Sir E. Denison Ross: Travel and Travellers of the Middle Ages (VIII.). Travellers' Tales and the Kingdoms of Prester John, A.D. 1150–1550.

UNIVERSITY COLLEGE, at 5.30.—C. R. Sanderson: The Library Resources of London.—Prof. T. B. Wood: The Nutrition of the Young Animal (I.). (Succeeding Lectures on March 11 and 18.)

THURSDAY, MARCH 5.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 4.15.—Dr. C. Singer: The History of Influenza, Diphtheria, and Typhoid Fever. (Succeeding Lectures on March 12, 19.)

SATURDAY, MARCH 7.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Modern Excavations in Egypt.



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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2888, VOL. 115]

Medical Research in Great Britain.[1]

THE Report of the Medical Research Council for the year 1923–24 to the Committee of the Privy Council for Medical Research consists for the most part of a condensed epitome of the results already achieved during the year by research workers wholly or in part financed by the Council The large number and great variety of the researches undertaken make it impossible to refer to them individually in this article. Mention will, therefore, be made of a few subjects only which, either from the completeness of the issue arrived at or from the interest of the results obtained at the present stage of the inquiry, force themselves upon the attention.

Results of far-reaching importance are being achieved by the committee appointed under the chairmanship of Prof. J. Barcroft to investigate the properties of hæmoglobin ; and a paper on the correlation between the spectra of various hæmoglobins and their relative affinities for oxygen and carbon monoxide has recently been published from Prof. Barcroft's laboratory in Cambridge. Using the Hartridge reversion spectroscope, it was found that a relationship existed between variations in the gas-binding affinities of different hæmoglobins and in the character of the α-bands. These variations appear to be conferred on the hæmoglobin by differences in the protein part of the molecule.

That light was a potent means of disturbing the equilibrium between hæmoglobin, carbon monoxide, and oxygen was confirmed by the investigators engaged in this research, and its action on other biological processes is being intensively studied by many workers at the present time. It has been found that the bactericidal power of blood is raised by exposing the skin of the subject to ultra-violet radiation, the exposure causing in some obscure manner a greater avidity of the leucocytes for the organisms with which they come in contact. This result may be related to the now well-known beneficial action of sunlight in tuberculous infection in man, an action which is being demonstrated with such success by Rollier at Leysin and by Gauvain in Great Britain

It is not alone in its power of increasing the resistance of individuals to microbic infection that light is being exploited in research schemes at the present time Rapid progress is being made in the elucidation of the relation between irradiation and dietetic deficiency. It had previously been shown that exposure of rats fed on a diet deficient in fat-soluble vitamins to ultra-violet radiation was capable of bringing about normal growth. This effect was found to persist if the containers in which the animals lived were irradiated, and the result was interpreted as pointing to some property

[1] Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the year 1923-1924. Pp. 142. (London: H.M. Stationery Office, 1924.) 3s 6d. net.

conferred by the ultra-violet light on the air in the immediate environment. Independent experimentation, however, failed to confirm this; and quite recently the original observers of the phenomenon have come to the conclusion that the positive results obtained by them were due to the presence of sawdust in the glass containers during the period of irradiation. When a piece of deal board was substituted for the dust an intermediate rate of growth was found. No precautions were taken to prevent the animals consuming some of the sawdust or gnawing away pieces of the irradiated board; but experiments at present in progress suggest that actual ingestion of the irradiated material is not essential for its beneficial action.

This result, if confirmed, is clearly one of fundamental and far-reaching importance. In the experiments referred to, the values for calcification of the bones were found to follow those of growth very closely. Whatever the nature of the emanations from these materials after exposure to ultra-violet light may happen to be, it is clear that a whole new field for research is rapidly opening up. What substances are capable of "phosphorescing" in this manner? Is vitamin A, the origin of which we know to be absolutely dependent on sunlight, a substance in which the power of absorbing ultra-violet light and converting this energy into a form of emanation having a potent effect in controlling the vital processes of growth and calcification, and is it developed to an extreme degree?

The Standards Department of the National Institute for Medical Research has now practically completed the work involved in the preparation of a stable dry standard of insulin. The Toronto unit will be defined in terms of this standard, which should then serve "as a currency for its transmission to all countries."

Much work is in progress on the nature and location of the action of insulin, when injected into animals, in causing the well-recognised fall in the blood sugar concentration. It had previously been shown by two Canadian physiologists that the isolated mammalian heart perfused with Locke's solution caused a fall in the sugar content of the perfusate, and that this fall was accentuated by the addition of insulin. The destiny of this extra quantity of sugar which disappeared remained, however, obscure. The question has recently been reinvestigated at the National Institute for Medical Research. Determination of the quantity of sugar disappearing in a given time, and the amount of carbon dioxide produced by the heart during the same period, have shown that in the absence of insulin there is a yield of carbon dioxide greater than can be accounted for solely by the combustion of the glucose removed. In the presence of insulin, however, the reverse is the case.

It is certain, therefore, that under the latter conditions part of the sugar is not oxidised, and at the present time the form into which the sugar has been changed remains obscure. It has been possible, however, to exclude certain hypotheses, such as that of the transformation of some of the sugar into fat, from a study of the respiratory quotient of the decapitated and eviscerated animal under constant infusion of dextrose. In such a preparation, insulin causes the characteristic fall in blood sugar, even when the muscles are inactivated by curare, without any change in the respiratory quotient which remains throughout at unity. Immediate transformation of the sugar into fat, or into lactic acid, seems therefore to be definitely excluded. Furthermore, investigations at Cambridge have shown that the heat production of isolated frog's muscle is unaffected by the presence in the surrounding fluid of relatively large concentrations of insulin. Recent work, too, on the sugar consumption of the heart-lung preparation has failed to show an increase in the rate of disappearance of this substance from the circulating blood on the addition of insulin. Insulin apparently is essential at some stage on the anabolic ladder of glycogen formation, though it will be clear from the foregoing account that we are still ignorant of the intimate nature of its action.

Studies of the excess metabolism of muscular exercise in man over and above the resting level have shown that this, provided the exercise is short-lived, has a respiratory quotient of unity. Experimental evidence all tends towards the conclusion that muscle is capable of metabolising directly carbohydrate alone.

It will be apparent from the few foregoing examples of work which is being pursued in the physiological and biochemical laboratories of Great Britain, that these two sciences are extremely virile and rich in productive effort. Turning to experimental medicine and clinical research, we find that here again much progress is recorded and "the Council are of opinion that during the past five years these University clinics have wholly justified their foundation by their success." Where the material for research is human, it is unavoidable that advance should be slower than in the sciences contributing to medicine. Furthermore, we must remember that the staffs of the medical and surgical units of the London hospitals are not in a position officially to exercise their option as to the type of case admitted to their wards any more than their colleagues on the remaining hospital "firms."

For teaching purposes this is no doubt an advantage, but it must inevitably break any attempt at co-ordinated research into the mechanism of the disturbances which culminate in disease. The first effective trial unit made by the Medical Research Committee, namely, the

Cardiac Department of University College Hospital Medical School, has more than justified its existence. This unit is unique in that it is engaged in an intensive study of the physiology, pathology, and nosology of one system only; a fact which is probably not unrelated to the richness of its scientific produce. The conception of "capillary pulsation" as a sign primarily of high pulse pressure, and in consequence a common accompaniment of aortic insufficiency, has been shown to be erroneous, the main causative factor of the phenomenon being a "widening of the arterioles of the skin or mucous membrane in which it occurs." The capillaries of the human skin have been shown to be capable of exerting relatively high pressures (from 50 to 100 mm. of mercury) when they are stimulated to contract by light stroking of the skin. Injury to the skin, on the other hand, leads to a train of vascular changes—dilatation and increased permeability of the minute vessels—which is conditioned by the liberation from the injured cells of a substance akin to histamine. To quote from an original paper,

"from the simple reactions of a healthy skin to the relatively mild stimuli such as are experienced daily by almost all; through the more serious, though trivial, local injuries, the bruise, the blister and the small scald, which find their simple household remedies; to the most grave mechanical injuries and extensive burns which in their late manifestations endanger life, we pass by transition It begins to be apparent why this transition is throughout a transition of quantity and not of quality; for underlying the whole series of reactions there is seemingly one chief determining cause, the unvarying reply of the affected cell to injury; this response of the cell, protective as it is to the cell itself, when united with that of neighbours, produces a massive action, threatening or terminating the life of the organism as a whole; an example which is not the sole example of conflict between the cell and the community of which it is a member."

In the introductory review by the Council of its second quinquennium, attention is directed to the unsatisfactory position and progress of pathology and bacteriology. It is pointed out that in Great Britain this is in part due to the "accidents of historical circumstances," but that "in all countries bacteriology is halting for more intimate knowledge of the infective organisms and of their biochemistry, while pathology only shows promise of advance in so far as it proceeds as a study of the reactions of the body to disturbance, as a part indeed of physiology, and in so far as it can express its phenomena in terms of biochemistry."

The munificent benefactions which these two sciences have recently received at the Universities of Oxford and Cambridge through the generosity of the Dunn Trustees, the Rockefeller Foundation, and Mr. Ernest Gates, coupled with their full recognition by the universities as being sciences laudable of pursuit, will, however, doubtless raise their position rapidly and effectively to the level and productive capability of those sciences which are less directly concerned with the alleviation of human suffering.

It is impossible to read this Report of the Council without being impressed with the wide range of its activities and the wisdom it displays in allocating the funds entrusted to it by Parliament for the furtherance of medical research. E. B. V.

Geography and World Development.

Geography and World Power. By James Fairgrieve. Fifth impression. Pp. viii+373. (London: University of London Press, Ltd., 1924.) 5s. net.

North America: an Historical, Economic, and Regional Geography. By Ll. Rodwell Jones and Dr. P. W. Bryan. Pp. xiii+537. (London: Methuen and Co., Ltd., 1924.) 21s. net.

Europe. Vol. 1: *The Peninsula.* Edited by B. C. Wallis. (Stanford's Compendium of Geography and Travel, New Issue.) Pp. xxiii+763+40 maps. (London: Edward Stanford, Ltd., 1924.) 15s. net.

The New World: Problems in Political Geography. By Dr. Isaiah Bowman. Revised and enlarged edition. Pp. vi+630+112. (London, Calcutta and Sydney; G. G. Harrap and Co., Ltd., 1924.) 21s. net.

Elementary Commercial Geography. By Dr. Hugh Robert Mill and Fawcett Allen. Pp. ix+194. (Cambridge: At the University Press, 1924.) 4s.

MODERN science has changed the size and shape of the earth. Time is the measure of its distances and routes the framework of its shape. London is nearer to New York than to Kashgar, and the Pacific Ocean, once the limits of the Orient and Occident, is now becoming the strategic and economic centre of a new world based upon the universal ocean. The latest development is a bi-weekly service of motor cars across the French Sahara. The adjustment of human activities to physiographic conditions has been in progress from before the dawn of history, and human institutions have shown that they are no more permanent than the "everlasting" hills.

The author of "Geography and World Power" defines history in its widest sense on its material side as the story of man's increasing ability to control energy. In a most suggestive book he gives a series of excellent studies, showing how empires and states have developed conformable to certain major phenomena of a physical order, and how a change in geographic values has effected changes in the relative importance of nations. Some, no doubt, will quarrel with the word "control," and especially so when it is urged that

"Men may advance or fall behind because the geographical conditions affecting their bodies react on their minds"; and again: "In the long run the geographical conditions are more powerful than the genius of individuals, more powerful even than racial characters, unless these racial characters are due to geographical controls."

The genius of mankind shows itself in its adaptability to new physical environments and an increasing ability to harness or to modify certain natural phenomena. The modern farmer in Saskatchewan shows an entirely different adjustment to the natural conditions from that of the Indians who preceded him, though no doubt the influence of the prairies is as marked on the social and economic life of the present inhabitants as on the culture of the Plains Indians, their former occupants But time is on the side of man. The cutting of the Suez and Panama canals, the irrigation works of California and S E. Australia, are of the same order as the works of Nature which are said to be "controls"; and these are but an earnest of still greater scientific achievements. The hot deserts may not only be made to blossom as the rose, but these areas of excessive insolation may also become the power stations of a new age when man has used up his capital energy of oil and coal. Nevertheless, the main thesis holds true that world power, at present, is closely related to the ability of man to utilise the physiographic conditions of his region. A knowledge of the manner in which man to-day is adjusting himself to the modern complex conditions of world occupancy ranks high in the essential sciences *Wissen ist Macht—Geographisches Wissen ist Weltmacht!*

The volume on North America furnishes not only innumerable illustrations of these principles, but also shows how these principles operate in the modern world. The first part traces the influence of physiographic conditions on the progress and development of settlement in America by emigrants from Europe. The second indicates the conditions which have arisen in North America from the application of modern science to the utilisation of coal, oil, and iron, and to the cultivation of wheat and cotton, both groups being extractive industries which are essentially localised The third part reviews these historical and economic considerations from a geographical view-point, and discusses the present-day adjustment of life and labour which makes the geographic region a more powerful entity than the individual state. Both the localisation of industries, as the iron and steel on the Pennsylvania coalfields, and the cultivation, and in these days the manufacture, of cotton on the warm fertile lands of the Atlantic and Gulf plains, give rise to regional interests of a very definite character. Dr. Bowman states in his book, "The New World," in a section devoted to America: "To a much greater degree than an outsider might suppose, and in spite of all the patriotic assurances to the contrary, there is a deep underlying question in the minds of thoughtful men in the United States as to the continued unity of the nation." He reiterates the words of Prof. Turner that to-day the United States is a federation of sections rather than of states, and that even a map of political votes roughly outlines the geographic provinces of the country.

Regional development is not, however, antagonistic to national unity. Indeed, it often furnishes the driving force of political or economic expansion. Most of the world-development problems of our time are questions of political or economic frontiers largely developed by expansive forces generated regionally within the political boundaries. Regional consciousness is expressed within the nation, national consciousness within the world itself Though there may be, and often is, a physical and historical background, the delimitation of political divisions is often of an arbitrary character. Europe bears on its new political map the evidences of both the constructive and destructive forces let loose by the War. The pre-War tendency towards consolidation into great and powerful states has been followed by disintegration into innumerable new states, as Poland, Czechoslovakia, and Yugoslavia, the uprising of which can be explained, if not also justified, by considerations of a physical, racial, or economic character. As a statement of the new political position within the "peninsula" of Europe, together with a certain amount of useful data about each state, the volume on Europe serves as an excellent reference book. It is what it claims to be, a "compendium" rather than a geographical treatise. Such is the organisation of a modern state that, complex as may be the adjustment of life and labour to the physical conditions of the area, it forms a body politic capable of determining policies affecting not only its internal but also its external affairs. Political lines will sever what Nature has joined, often dividing physiographic or economic regions into two or more geographic entities, as between the United States and Canada or between France and Belgium. On the other hand, political boundaries may bring a number of regional entities into a single political expression, as in the United States or France.

Though the political divisions may be somewhat arbitrary, the regional divisions within the state tend to be based on considerations of an economic character, which in turn may rest largely on physiographic foundations. The region has a distinctive life of its own, and the regional consciousness is more than the whirr of

its machinery or the rattle of its trains and lorries. It springs from an adjustment of life and labour to the area, and it lives, not so much because of the factors which brought one or more of its industries into being, but because of its functions to-day. A British company desirous of erecting additional cotton mills would place them in South Lancashire, not because of those factors which first attracted the industry, but because to-day the region possesses the machinery for dealing with the cotton trade; there are located the necessary subsidiary trades, and there is the great reservoir of labour skilled in the processes of cotton manufacture.

South Lancashire to-day lives, no doubt, on cotton, but fate has not decreed that it must die if cotton be withheld, providing the withdrawal of the raw material is sufficiently gradual to allow a readjustment to new activities. Man's salvation lies in his adaptability. London, like some urban Vicar of Bray, has accommodated itself to and grown with the changing conditions of the British Isles, thereby retaining the premier position in trade and commerce. If geographical science can so study what one may call the anatomy and functions of the region, diagnosing incipient diseases and prescribing cures, it will render invaluable aid not only to the body politic of which the region is a limb, but also to the millions of people whose lives are more or less anchored to the area. Must New England necessarily perish because the Southern States have now entered into competition with it?

"North America" and "The New World" furnish innumerable illustrations of world development, both in the purely geographic region and in the political region, which in these days assumes a geographic form. The former to-day conforms largely to an economic or physiographic foundation, because a region, like an individual, must in general live by work. One example from "North America" must serve. The broad indentation of the east American coast between Capes Cod and Hatteras appears on a relatively small scale map as an unnamed bay sweeping inward to the foothills of the Appalachians, broken in outline by three large inlets, Long Island Sound with the Narrows, and Delaware and Chesapeake Bays. These give access to river valleys which lead across the mountain barrier to the rapidly developing manufacturing and agricultural regions beyond. Population in the narrow belt of broken lowland has gathered round the three port nodals of New York, Philadelphia, and Baltimore. They and the surrounding districts form a region of considerable importance, though it is not easy to state exactly the causes of its growth. The most powerful may well be the very size and adjustment of the present population, compelling the consideration of the factors of its origin to be made in the light of modern demands and opportunities. What is said of New York, London, Berlin, and Paris may be applied to all great ports and their hinterlands. "Every individual quota to provincial population, whether industrial or agricultural, has its counterpart in metropolitan expansion." Every development in the hinterland has a corresponding development in the port. Yet Salem in New England and Chester in old England failed to keep the developing traffic of their hinterlands, and succumbed to Boston and Liverpool respectively. Great and prosperous cities have declined, and often the germ of decay has been secreted in the heyday of prosperity. When geographical science can not only observe accurately the full foundations of regional prosperity, but can also form an estimate of the vitality and capabilities of the region, it will have made a contribution of prime importance to mankind.

The political region or state presents a geographical study of a somewhat different order. The very rigidity of the frontier is incompatible with the economic development within and the expression of the national consciousness without. "The New World" is an exhaustive and masterly study of problems in political geography. They are problems of the frontier, either political, economic, or social. Dr. Bowman asks: "Will the changes in the political and economic geography of the world spell peace or war, strength or weakness, in the years immediately before us?" He then makes the comment that there are about 10,000 miles of boundary round the states of central Europe alone, of which more than 3000 represent newly located boundaries. "Every additional mile of new boundary, each new location, has increased for a time the sources of possible trouble." Indeed, it may not be too much to say that the conflicts of expanding frontiers have probably been far more determinant of historical development than the physical conditions over which these frontiers have passed.

The principal cause of regional growth, accompanied by economic or political expansion, lies in the increasing ability of man to develop and utilise the world's resources. This ability is most evident in the large, well-organised states, and creates not only the desire but also the power to push outwards into the world market. Economic or commercial geography throws considerable light on the character and direction of these movements, affecting not only the Great Powers of the world, but also the many states of Europe and Latin America. The "Elementary Commercial Geography" is a useful introduction to this aspect of geographical study.

The effect of the frontier in American history has long been recognised. But the expanding frontier did not rest on the shores of the Pacific States. In

Alaska and the Aleutians, Central America and the Caribbean Sea, in Hawaii, the Philippines, and other Pacific Ocean islands, the United States has extended its political possessions, and this has been accompanied by a still greater expansion of its commerce and prestige in South America and the Far East Britain, France, Japan, and other nations differ from the United States not in kind, but merely in degree The consequence is that world development is being accompanied by conflicting interests over wider areas than the mere frontier zones of individual states Countries nominally independent, as China, and states under the administration of European powers, as those of Africa, are feeling the effects of world development Moreover, the change in the regional life is not measured merely by the change in economic values There is a profound change in the people themselves The old order changes, giving place to new. A new orientation and a new outlook are rapidly being developed The population, under the external stimulus from Europe or America, is adjusting its life and labour anew to the physiographic conditions and possibilities of the region The African, the Egyptian, the Chinese, and a thousand other "questions" arising with world development have a regional basis, and demand the urgent and careful investigation of the new science of geography

Some Sponges of the Southern Seas.

British Museum (Natural History), British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Zoology Vol. 6, No. 3. *Porifera.* Part 1: Non-Antarctic Sponges. By Prof. Arthur Dendy. Pp. 269 + 392 + 15 plates. (London: British Museum (Natural History), 1924) 17*s* 6*d*.

PROF DENDY has produced a very beautiful and elaborate memoir on the sponges collected by the *Terra Nova* expedition in the southern seas. It is possible that such a highly technical piece of work may appeal only to a few readers at the present moment, but it can nevertheless be recognised as a permanent and important contribution to zoological science.

The modern developments of biology in the directions of embryology, the problems of heredity, experimental zoology, and comparative physiology have proved to be especially attractive to the younger generation of biologists, and no one can deny the value and importance of the scientific results of their work in the new fields of research that are being opened It must be remembered, however, that the accurate and detailed description of new and old species, especially when it is accompanied by sound judgment in systematics, and careful consideration of the possibilities of natural variation and powers of adaptation to environment, is an important and indeed fundamental branch of the science of zoology. There is indeed a pressing need, at the present time, for more work of this description if we are to keep pace with the receipt of specimens that collectors are sending to Great Britain from all parts of the sea and land. To workers in this line, Prof. Dendy's account of the sponges may well serve as a model of what such monographs should be, and it is a great satisfaction to realise that some of our ablest zoologists are still willing to devote their time and expert knowledge to the production of systematic treatises of a high standard of merit.

All the sponges, except three, described in this memoir were obtained by five hauls of the dredge in water extending from the shallows to a depth of 100 fathoms off the north of New Zealand The cruise revealed a very remarkable and, at the same time, a very rich fauna of sponges in these seas, such as has not yet been equalled in any region of the world In these five hauls no less than 90 species were discovered, and of these 62 appear to be new to science. If it were to occur to any one on reading this statement in the introduction that in such a restricted area some of these species must be variations or mutations of relatively a few species, such a criticism would be dispelled by the careful description of the form and particularly of the spicules of the sponges the author describes.

The problems associated with the occurrence of such a remarkable assembly of organisms of the same group competing fiercely with one another for the advantages of the situation are not ready for solution, but the record of this wonderful sponge fauna is of importance in the science of the distribution of animals, and should not be lost sight of or forgotten because it is buried in a systematic treatise.

It is difficult to select from the many detailed descriptions of species the points of special interest for the general zoologist. The extraordinary range in form and structure of sponge spicules and the numerous technical terms that have been invented for them may be bewildering to those who are not well acquainted with the literature of the group, but there seems to be no doubt that in the Porifera the spicules are more constant in character for each species, and therefore more valuable for systematic purposes, than they are in the Alcyonaria. Accurate description and careful illustration of the spicules is an essential feature of a good monograph on sponges.

The discovery of two fine new species of the interesting group of hexactinellid sponges is a welcome and noteworthy point in this work.

The monograph is well illustrated by fifteen quarto plates, and we have to thank Prof. Dendy also for a good index.

The Rat Menace.

Rats and How to Destroy Them; dealing with Rats in a House, Shop, Warehouse, Outbuilding, Yard, Stable, Cow-house, Fowl-house, Pig-sty, Garden, Greenhouse, or Vinery; by a River, Stream, or Ornamental Water; on a Ship, Shooting Estate, or Farm; and in Sewers. By Mark Hovell. Pp. xlii+465. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 10*s.* 6*d.* net.

IT has been estimated that the damage caused by rats to the food supply and buildings in Great Britain alone represents a loss of something approaching 50 million pounds a year. In addition to this, the rat is a serious menace to society as a carrier of disease; the occurrence of infectious jaundice in epidemic form on the western front during the War and more recently in Scotland, where a mortality of 40 per cent of cases occurred, has directed attention to a new danger near home, for which the rat is responsible. It is common knowledge that rats are prolific, but few people realise the rapidity with which their numbers increase. The litter in an adult rat varies from 8 to 16. Rats breed throughout the year, the period of gestation is only 21 days, and impregnation may again take place within a few hours of the birth of a litter.

A very moderate estimate of the number of descendants of one pair of rats born during one year is well over a thousand, and these in the course of three years will have increased to a quarter of a million; these calculations are based on litters of 10, and only 6 litters in the course of a year are allowed for. A single pair of rats will eat more than 80 quartern loaves or their equivalent in a year, and their descendants in the same year will eat more than 46,000 loaves or their equivalent in wheat or flour.

After reading the introductory chapter of Dr. Hovell's book in which these and many other interesting facts are lucidly presented, one cannot remain apathetic to this ever-increasing menace to humanity. The remainder of his book deals chiefly with all the known methods of preventing the spread of rats and destroying them in every conceivable situation. Traps of every description are described, with many illustrations, and the relative values of all the better known forms of rat poison are dealt with. A very interesting chapter is devoted to the history of bubonic plague, and the way in which it is carried by the various rat fleas. It is interesting to note that, even in Old Testament times, rats were in some way held responsible for the spread of plague, continual reference being made to "golden mice" which were made "as an offering for the Plague."

There is a short section on rat cancer and the life history of the nematode (*Spiroptera neoplastica*) which causes this disease in the stomach of the rat and passes its larval stages in the muscles of a species of cockroach. In this and in his remarks as to the possible relation of human cancer to cockroaches, the author is perhaps a little misleading, as he does not state that the cockroach in question is the New World cockroach *Periplaneta americana*, and not *Blatta orientalis*, which is the one common in Europe.

There is an appendix dealing with a scheme for the organised destruction of rats throughout the country, but though this would seem to be a highly desirable step, it would require special legislation to enforce.

The book is one which will direct public attention to a very real menace and at the same time be of the greatest assistance to those who are brought into direct conflict with that menace.

Our Bookshelf.

Masters of Science and Invention. By Floyd L. Darrow. Pp. v+350+24 plates. (London: Chapman and Hall, Ltd., n.d.) 10*s.* 6*d.* net.

IN recent years progressive science teachers have been pondering the problem of "humanising" scientific instruction, of introducing the breath of life into the "valley of dry bones" of experiment, observation, and inference, and thus in a measure treading on the ground hitherto monopolised by the humanists. The work under notice represents an attempt in this direction. The author has set himself the difficult task of giving, in simple biographical form, an account of the development of scientific achievement, and he states that "no knowledge of the laws of science and their manifold applications is even approximately complete without acquaintance with the outstanding figures who have made possible the age in which we live." In the twenty-eight chapters, each of which is more or less complete in itself, we are given an excellent bird's-eye view of the march of discovery and invention, which will especially appeal to the young—in years or knowledge.

Although we may question if biography is essential to the understanding of the content and method of science, there can be no doubt that its inclusion is a most valuable stimulus, particularly to that large majority which prefers the study of man to the study of Nature. This book is a very useful addition to popular scientific literature; the arrangement is good, the style is clear and vivid (but why, oh why, does the author never use a colon or a semicolon?), the selection of "masters"—an invidious task—is good, and the statements are generally accurate. Two errors in the chapter devoted to briefer biographies should be corrected: Sir Ernest Rutherford is no longer professor of physics at Montreal, and the late Sir William Crookes was never a professor either in the Royal College of Science, Oxford, or elsewhere.

An analysis of the nationalities of the men who are noted at length in this volume may be of interest. Of the men of science, about one-third are British, one-fifth French, one-sixth German, one-fifteenth each

American (U.S.A.), Swedish, and Swiss; whilst ninety per cent. of the inventors are either American or British. If these figures may be taken as a rough index of the distribution of scientific and inventive genius, it would appear that although science has no fatherland (as Pasteur said), invention can make out a good claim for the English-speaking world.

Complex Salts. By Dr. William Thomas. (Manuals of Pure and Applied Chemistry.) Pp. xi+122 (London, Glasgow and Bombay. Blackie and Son, Ltd., 1924.) 10*s*. net.

DR THOMAS'S book on "Complex Salts" is a small volume of about 120 pages, intended more especially for students reading for final and honours degrees. It differs from a recent book by Schwarz on "The Chemistry of the Inorganic Complex Compounds" (see NATURE, October 27, 1923, p. 617) in that it deals in a much more general manner with the problems of molecular asymmetry, optical activity, methods of resolution and rotatory dispersion of optically-active complex salts. On these subjects Dr Thomas has himself done important original work.

A novel and extremely valuable feature of the text is a chapter on the "Preparation and Resolution of Inorganic Complex Salts," including two examples of resolution, one involving the use of an active acid, and the other the use of an active base. This chapter should be of great value in enabling an honours student, or a young research worker, to secure experience in the manipulation of this important group of compounds. The book is presented in an attractive form, but the price appears to the reviewer to be rather high in view of the small size of the volume, although the price per page is appreciably less than that charged for the English translation of Schwarz's book.

The equilibrium-diagram which represents the case in which a racemate is formed when the temperature is raised, instead of (as in the case of sodium ammonium tartrate) when the temperature is lowered, appears to have been omitted, since Fig. 3, p. 60, represents the unsymmetrical diagram for a double salt which decomposes above a transition-point. It is not immediately obvious from the text what has gone wrong, and a student who encountered this error without knowing the correct form of the diagram might be puzzled for a long time before finding the correct interpretation.

The High Grass Trail: being the Difficulties and Diversions of Two; Trekking, and Shooting for Sustenance in dense Bush across British Central Africa. By Frank Savile. Pp. 255+10 plates. (London: H. F. and G. Witherby, 1924.) 15*s*. net.

THIS is a day-to-day account, written in an easy and pleasant style, of a shooting trip, undertaken in the high grass season, to Nyasaland and Northern Rhodesia. As no map has been provided, and most of the places mentioned are not marked on the ordinary map one has at hand, it is not easy to follow, except in a general way, where the author really did go.

This part of the world seems to be a veritable sportsman's paradise, both as regards small and big game. There was something to shoot almost every day. The natives are extremely friendly and willing to assist in all operations of shikar. Their intense desire for meat makes them very ready helpers where big game is concerned. In a country where supplies are so scarce it is necessary to ply the gun in order to keep the larder replenished, and provide food for an army of carriers. Some game, however, is not exactly up to the white man's standard. Of zebra meat the author remarks: "It is dark, unwholesome red, greasy and revolting. I have tried the brains and tongue, which are passable, but so far, to Allah be praise, have never had to set my cheap German teeth the task of masticating its steaks or cutlets," but "the ordinary nig. loves it."

None of the problems of the country are dealt with. It is purely a book for the sportsman, and any one contemplating a visit to British Central Africa for shikar purposes should certainly read it. It will give him a good idea of what to expect as well as a considerable amount of entertainment. H. L. C.

Chambers's Encyclopædia: a Dictionary of Universal Knowledge. New edition. Edited by Dr. David Patrick and William Geddie. Vol. 4: Dioptrics to Freistadtl. Pp. iv+856. Vol. 5: Fréjus to Humboldtia. Pp. iv+840. (London and Edinburgh: W. and R. Chambers, Ltd., Philadelphia: J. B. Lippincott Co., 1924.) 20*s*. net each vol.

THE most recent volumes which have appeared of this handy encyclopædia carry the alphabet nearly to the end of the letter H. They are well supplied with finely produced coloured maps, of which the historical maps of Europe and the physical and geological maps of Great Britain are particularly useful. Most of the articles of the last edition have undergone revision, in some cases by the original writers, and references to recent events have been added. Other articles have been re-written. Many of them are models of summarised knowledge, and several on the more important subjects run to considerable length. Thus "electricity" covers twenty-six pages, with another eight pages on cognate subjects. "Eye" runs to twelve and "fishes" to seven pages. Cross-references enhance the value of the work, but do not occur so frequently as to impede quick reference.

Elementary Experimental Statics for Schools. Written by A. P. McMullen. Revised for the Press, with some additional Matter and a Preface, by E. W. E. Kempson. Pp. vii+315. (Cambridge: At the University Press, 1924.) 8*s*. 6*d*.

IF the object in teaching a subject such as statics to schoolboys is not so much to give them anything in the nature of a logical training as to render them appreciative of the fundamental principles and convinced of their truth, no better system can be adopted, we believe, than the experimental method. Especially is this the case in the present age, when boys display a lively interest and knowledge of machines, and appear to have relatively little difficulty in grasping the idea of mechanical work. It is for this reason that the authors of the present book have developed their subject in the order work, moments, triangle of forces, dealing in their appropriate places with friction, centres of gravity, equilibrium and stability. The result is that they have produced a book which must be of real value to all teachers of the subject. The illustrations are copious and instructive.

Letters to the Editor.

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Local Reflection of Wireless Waves from the Upper Atmosphere.

In some recent experiments carried out for the Radio Research Board of the Department of Scientific and Industrial Research, measurements have been made of the diurnal variation of the signals received at Cambridge from the stations of the British Broadcasting Company. During the day-time these signals have been found to be fairly constant, but night-time variations of intensity have been measured at distances from the transmitter so short as 50 miles. For example, the signals from London at Cambridge are found to be constant during the day; but, at about sunset, variations, which are often of a periodic character, begin, and continue through the dark hours. In this case the mean night value is very little different from the day value. For more distant stations (for example, Bournemouth) the phenomena are different. During the day the signal is weak and constant, but after sunset the intensity increases and, though variable, the signal maxima may be several times the day value. In this case the variations in signal intensity are larger, less rapid, and less markedly periodic than in the case of the London signals.

These effects may be explained in a general way if an atmospheric reflecting layer is postulated which is comparatively ineffective for the waves of this frequency during the day-time but bends them down very markedly at night. According to this view two rays arrive at the receiver at night, one nearly along the ground, which may be called the direct ray, and the other returned from the atmosphere, and called the indirect ray. In the case of the London signals the direct ray is considered as being strong and constant compared with the indirect ray, and the night-time variation is considered as being due to interference between the direct and the weak indirect ray. For the longer distance transmission, the stronger night-time signal is to be attributed to the indirect ray.

If the reflecting stratum is imagined to be at a height greater than say 50 kilometres, the above interpretation indicates bending back at relatively small angles of incidence (for example, if London is considered, and the height is assumed to be 100 kilometres, this angle of incidence is about 22°). Such high grazing angle reflection from the Heaviside layer has not usually been considered possible, and we have therefore attempted to examine the phenomena in a more direct manner. The method adopted has been to vary the frequency of the transmitter *continuously* through a small range and attempt to detect the interference phenomena so produced between the two rays. From our measurements it was estimated that at a distance of about 160 kilometres from the transmitter, the effects of the direct ray and the indirect ray at night would be approximately equal.

The British Broadcasting Company, on being approached, very kindly consented to collaborate in the experiments and to use the Bournemouth station as the transmitter. Oxford, being about 140 kilometres from Bournemouth, was chosen as the receiving site, and excellent facilities for the installation of the receiving station were provided for us in the Oxford Electrical Laboratory by Prof. J. S. Townsend and Mr. E. W. B. Gill. Capt. A. G. D. West, of the B.B.C., who was in charge of the Bournemouth end of the experiment, arranged the transmitter so that a known frequency change could be produced uniformly during a given time (for example, 10 to 30 seconds) while the aerial current remained practically constant. The received signal intensity at Oxford was determined with a receiver specially designed to give approximately uniform sensitivity over this band of frequencies. The resulting signal currents were measured by moving coil and small Einthoven galvanometers. Mr. F. G. G. Davey gave us most valuable assistance at the receiving station. Land-line communication was also maintained between the two stations during the period of the experiments for control purposes.

Two sets of experiments were carried out on December 11, 1924, and on February 17, 1925, and in both cases quite definite examples of successions of interference bands were observed as the wave-length was changed, the intensity varying from a maximum value almost to zero as was arranged for by choice of distance. If we assume the simplest interpretation of these interference phenomena and regard them as analogous to those of a Lloyd's mirror fringe system, the effects may be viewed as follows. For a direct ray path of length a, a higher ray path of length a' and a given wave-length λ, the higher ray arrives N wave-lengths behindhand as compared with the lower ray where $N = (a' - a)/\lambda$. If N is an integer the waves steadily reinforce unless a' is changing, while if N is halfway between two integers they are steadily opposite in phase. If the wave-length is gradually increased to λ' at the sending station, alternations of intensity may be expected, the number being $(a' - a)/\lambda - (a' - a)/\lambda'$. The experimental observations according to this simple interpretation indicate a path difference $(a' - a)$ of the order of 80 kilometres, which is consistent with a reflecting layer at a height of about 85 kilometres. Evidence was, however, obtained that the results may be somewhat complicated by the elliptical polarisation of the indirect ray, in which case the above estimate of the height may have to be revised. Further experiments on this point are in progress. But the interference phenomena between two rays depending on the existence of a deflecting layer seem definitely established.

It has been usual to attribute the difference between day and night strengths of wireless signals to a difference in the sharpness of the boundary of the effective atmospheric layer, the lower boundary being assumed sharper by night than by day. We think, however, that the transition cannot be sharp compared with the wave-length, particularly for the short waves we have used, and therefore the term "reflection," used for convenience above, must be taken as meaning "ionic deflection."

We imagine, therefore, that at night the layer is sufficiently high and intense to permit of ionic deviation taking place, the ray being turned through large angles without undue absorption. During the day the ionisation due to solar agencies throws the ray down at lower levels (for example, 40-50 kilometres), and here, although ionic refraction can take place, the collisional "friction" causes heavy absorption at these short wave-lengths and high grazing angles. The difference in the action of the atmospheric ionisation between day and night is therefore to be taken as due to the differences in height (and therefore density) of the effective layer, and not as due to the difference in the sharpness of the boundary of the layer, as has been usually assumed.

These and other experiments suggest the inference that, at distances greater than about 100 miles from a wireless transmitter of these wave-lengths (for

example, 300-400 metres), night-time reception is dependent almost entirely on the upper indirect ray; and evidence is not lacking that, due to the more effective reflection by the ionised layer at smaller grazing angles, the signal strength maximum may in some cases increase with increase of distance from the transmitter

E. V. APPLETON
M. A. F. BARNETT

Cambridge,
February 21

The Propagation of Radio Waves over the Earth.

AMONG the facts to be explained in a satisfactory theory of the propagation of radio waves over the earth's surface are the curvature of the rays in transmission between stations far apart, the absorption during transmission, the peculiar phenomenon of fading, in which the magnitude of the received wave fluctuates more or less rapidly, the differences in transmission in different directions over the earth, and the extraordinary differences in the transmission of long and short waves.

This letter is to outline a new theory of transmission which accounts quantitatively for many previously unexplained facts of radio transmission. A detailed treatment of important cases will appear shortly.

The atmosphere to a considerable height above the earth contains ions which react upon electromagnetic waves and, as shown by Larmor (*Phil. Mag.*, Dec. 1924), may account for the bending of long waves around the earth. His explanation, however, does not show the large and characteristic differences between short and long wave transmission, which become especially marked in passing through the region between 100 and 200 metres. Other theories, also, have the defect of predicting entirely incorrect results for short wave-lengths.

The theory now developed takes into account both the earth's magnetic field and the distribution of ionised particles in the atmosphere. It is found that this field, together with the electrons, produces marked selective effects at wave-lengths between 100 and 200 metres, and that these effects are different for different directions of transmission and for different planes of polarisation of the wave. A summary of the effects follows.

For the case in which the electric force of the wave is parallel to the earth's magnetic field, the only effect is due to a variation in ionic density above the earth. This case is realised practically only over very limited areas of the earth's surface.

For transmission in any other direction or for any other direction of the electric field, four effects are in general produced, namely, the plane of polarisation of the wave is rotated by an amount depending upon the density of free electrons, the magnetic field, and the frequency. This effect reverses at the critical frequency, which, for a field of 0·5 gauss, is 1400 kilocycles (214 metres). The second effect is that of double refraction in the medium, producing two waves of different velocities and polarisations. The third effect is a bending of the rays due to a variation in ionic concentration, as in Larmor's case, but, due to the magnetic field, this bending also, in most cases, reverses at the critical frequency, so that if long waves bend down in a certain region, short waves will be deflected upwards in the same region. The fourth effect is a bending of the rays due to variations in the magnetic field strength, and this effect also reverses at the critical frequency.

The general solution of this problem cannot be given in this note, but some interesting special cases will be described.

For transmission from a vertical antenna along a magnetic meridian the electric vector tends to be rotated, and, when this rotation becomes equal to 90°, the usual methods of reception produce no signals; hence we should expect, in general, better reception of east-west than of north-south signals at certain points. Also, since the plane polarised ray can be resolved into two circularly polarised rays travelling with different velocities, under certain conditions both components may not be able to travel over the same path between two points.

The rotation of the plane of polarisation for transmission along the magnetic field is rather large, for example, the electric vector in a wave 2 km. long will turn from vertical to horizontal in about 80 wave-lengths if there are present only 10 free electrons per cubic centimetre in a layer for which the mean free path is sufficiently long for free motion. A wave 100 metres long will rotate through the same angle, but in the opposite direction, in about 5000 wave-lengths or 500 km. For larger ionic densities, appropriate to high levels, the waves may be rotated very rapidly, which is one of the causes of variable transmission along a magnetic meridian.

For transmission at right angles to the magnetic field, we find double refractions with the ordinary ray unaffected by the magnetic field and the other selectively affected.

In all these cases, the variation in the number of ions and in the magnetic field at different heights above the earth produces deflexions of the rays which may be calculated.

The introduction of a resistance term into the equations of motion of the electron leads to an attenuation factor in the equations of wave-motion. Thus, for transmission parallel to the magnetic field, the exponential term involves the reciprocal of the square of the frequency for frequencies sufficiently large compared to the critical value. This means, therefore, that attenuation due to this cause falls off rapidly as the frequency is increased. At the other extreme the same expression is found to apply, except that in place of the transmitted frequency, the critical value is substituted. Hence in this range attenuation due to this cause is constant. There are, of course, other causes of attenuation—for example, the conductivity of the earth.

When the frequency is near the critical value, large anomalous effects occur. For example, the wave may be required to travel over a widely different path by a slight change in either the magnetic field or the ion density. The signal may arrive at the receiver from several directions simultaneously or successively, producing fading or apparent change of direction. The absorption may become extremely high for certain rays.

The detailed theory, with its predictions, will be published soon.

H. W. NICHOLS.
J. C. SCHELLENG.

Bell Telephone Laboratories, Inc.,
New York City,
February 6.

Molecular Symmetry in Crystal Structure.

IT has been pointed out by Clark[1] that there is a great similarity between the structures of the four alkali polyhalides KI_3, CsI_3, $CsIBr_2$, and $CsICl_2$. They have the same arrangement of atoms in unit parallelepipeda, if the unit cells are chosen so as to contain one molecule. The arrangement is with the metal atoms at the corners of the cell and the halogen atoms inside the cell and in a line on the body diagonal.

[1] A. L. Clark, Pro. Nat. Acad. Sci., 9, 4, 1923, p. 112.

The same arrangement is taken up by the complex radicles in the hexammoniates of the nickel halides and the hexahydrate of zinc bromate. This body-centred grouping is a deformation of the arrangement in CsCl.[2]

A study of the chlorates, bromates, and iodates of sodium and potassium shows that similar relations exist between these salts. Some are closely related to cæsium chloride in structure, which we shall call the CsCl set, and the rest to sodium chloride, referred to below as the NaCl set. The distinction between the more complex salts and the simple halides is that in the former the chemical molecule can be identified, in the latter it cannot.

Sodium chlorate and sodium bromate have been studied by several workers.[3] They belong to the NaCl set, with four molecules per unit cell, the edge of the half-molecule parallelepipedon being 3·29 angstroms in the chlorate and 3·35 angstroms in the bromate.

The three potassium salts have been examined by the writer using the ionisation spectrometer, and the following results were obtained.

Potassium chlorate, which is monoclinic, belongs to the NaCl set. The half-molecule parallelepipedon has edges 3·56, 3·69, 3·69 angstroms. Potassium bromate is ditrigonal pyramidal (pseudocubic). Measurements on the spectrometer show it belongs to the CsCl set, the edge of the one molecule pseudocube being 4·46 angstroms. Potassium iodate is monoclinic (pseudocubic). The spectrometer method, and a photograph taken by the powder method, show that it belongs to the CsCl set. The edges of the one molecule parallelepipedon are 4·57, 4·50, and 4·50 angstroms.

No measurements have been made on anhydrous sodium iodate, but, from its form and specific gravity, it probably belongs to the CsCl set.

The great similarity between these more complex salts and the simple halides shows that the complex radicles act as single units and the molecule behaves as an electric doublet. Each radicle is surrounded, but not equidistantly, by six or eight oppositely charged radicles according as the crystal is of the NaCl or CsCl type. The question arises as to the possibility of determining the positions of the constituent atoms of the complex radicles, from symmetry conditions and intensity measurements.

The case of cæsium dichloro-iodide, examined very completely by Wyckoff,[4] indicates that this determination is impossible from symmetry considerations, and he attempts to fix the chlorine atoms from his intensity measurements alone, describing his results as very uncertain on this account. Symmetry considerations, following Shearer's principle,[5] show that the $CsICl_2$ molecule should possess a trigonal axis, which is impossible for any static arrangement of the ICl_2 radicle, since chemical considerations of stability, and the shape of the cell, negative the placing of the atoms in a line along the trigonal axis.

Another relevant case is that of the ammonium radicle in ammonium chloride. The radicle as a whole occupies positions in space which determine the crystal symmetry, and the positions of the hydrogen atoms cannot be determined. This conclusion is verified by the study of the ammonium alums.

There seems to be no valid reason for giving to the hydrogen atom alone the negative privilege of self-effacement in symmetry considerations, so long as it occupies space. The fact that the salts containing complex radicles which are considered above are so closely related to the simple halides leads to the conclusion that, for other radicles as well as ammonium, the symmetry is independent of the position of the constituent atoms in the radicle, the latter behaving as a unit. The crystal-forming forces are probably electrostatic attractions independent of any structural axes the radicles may possess.

The occurrence of what has been called ionisation in the simple halides has led to the conclusion that no deduction as to atomic symmetry can be made from their crystal structure. As I have pointed out elsewhere,[6] this "ionisation" probably indicates the presence of heat motion in the form of rotation. In the simple halides the radicles can rotate separately, since there is no molecular bond. In the more complex salts considered above, in which the chemical molecule exists, the molecule apparently rotates as a whole about the electrostatic axis of the doublet, and the positions of neighbouring molecules are probably determined by the sizes of the radicles and pressure considerations, similar to those described by Bartlett and Langmuir,[7] to explain the transition of ammonium chloride from the CsCl to NaCl type.

J. H. SMITH.

Physical Laboratory, University College,
London, January 29.

[2] R. A. Dickinson, J.A.C.S., 44, 1922, p. 1489.
[3] A. Karssen, Dissertation, Amsterdam, 1923; W. Kiby, *Zeit. f. Physik*, 17, 1923, p. 213.
[4] R. G. W. Wyckoff, J.A.C.S., 42, 1920, p. 1100.
[5] G. Shearer, Pro. Phys. Soc. Lond., 35, 1923, 81.
[6] J. H. Smith, *Science Progress*, Jan. 1924, p. 403.
[7] Bartlett and Langmuir, J.A.C.S., 43, 1921, p. 84.

The Atomic Weights of Zirconium and Hafnium.

IT is just a hundred years ago that the atomic weight of zirconium was determined by Berzelius. The method used, namely the analysis of the sulphate, yielded too low a value for the atomic weight, the same being the case in all the different methods used by his followers. This error was compensated, however, in part by the presence of 0·5 to 2 per cent of a heavy element (hafnium) in their preparations (see NATURE, March 15, 1924). It was only in 1917 that Venable and Bell, when analysing $ZrCl_4$, used a more trustworthy method originating from T. W. Richards's laboratory. The values found by these investigators were appreciably higher than those found by their predecessors, and showed at the same time fluctuations for the values of the atomic weight, greater than should be expected considering the extreme precautions taken and the reliability of the method used.

These fluctuations could not be accounted for at the time of the measurements. After the discovery of hafnium it suggested itself that the variations found by Venable and Bell were due to a varying hafnium content in the preparations used. Through the courtesy of Prof. Venable we have been able to investigate the samples used by him and by Dr. Bell, and have found a hafnium content varying between 0·7 and somewhat above 1 per cent. Taking into account this presence of an element having the atomic weight of about 180 in their preparations, Venable and Bell calculated the value 91·3 for the atomic weight of zirconium. This value is in an excellent agreement with the value (91·25) arrived at recently by Hönigschmid and Zintl (*Zeit. anorg. Chem.* 139, 293, 1924) using a preparation purified from hafnium in this laboratory and found to contain less than 0·02 per cent of this element. It is of great interest that the above numbers coincide closely with the value which can be estimated from experiments with positive rays. Aston found for zirconium the mass lines 90, 92, 94, and a doubtful one at 96, and estimates the atomic weight as 91·4 or 91·2, according to whether the mass number 96 is included as an isotope or not. We may, therefore, be justified in believing that the atomic

weight of zirconium is 91·3 with an accuracy of about 0·1 unit.

While the presence of 1 per cent. HfO_2 in a preparation of ZrO_2 influences the apparent atomic weight by 0·6 unit, the presence of 1 per cent. of ZrO_2 lowers the apparent atomic weight of hafnium by not less than 1·4 units One must thus obtain a hafnium preparation containing a very small amount of zirconium in order to fix the atomic weight of hafnium with an accuracy similar to that reached for zirconium. It was possible some time ago to supply Prof. Hönigschmid with such preparations from this laboratory The values found by him, when analysing $HfBr_4$, for the best preparation were 178·32 and 178·35, and for a less pure fraction 177·78 and 177·80. The samples used by Honigschmid and Zintl were recently very thoroughly investigated by Mr Thal Jantzen by means of the method of X-ray analysis, which when proper precautions are taken is able to give values of high accuracy and offers a simple method of estimating the zirconium content of hafnium preparations The values for the zirconium content of these preparations were found to be 0 16 and 0·57 per cent The values for the atomic weight found by Hönigschmid and Zintl have thus to be raised to 178·57 in the first, to 178·64 in the second case, and we may, therefore, with a probable error of less than 0 1 unit fix the atomic weight of hafnium at 178 6.

G HEVESY

Universitetets Institut for teoretisk Fysik,
Copenhagen, February 5.

Late Palæolithic Art in the Cresswell Caves.

I WRITE as chairman of the British Association Committee, now resuming, by permission of the Duke of Portland, the exploration of the Cresswell Caves where it was dropped some forty years ago by the Rev Magens Mello and myself, to prevent your readers from being misled by the following passage in the third edition of Prof Sollas's book on "Ancient Hunters," p 536

"There is a singular absence of any attempt at art in all the Palæolithic stations of England. The horse figured here [Fig 299] is, I am assured, a forgery introduced into the cave by a mischievous person."

The Cresswell horse was the first proof of the range into Britain of the wonderful art of the French caves, and the discovery made in the 'seventies by myself was published—after a careful scrutiny by Sir John Evans, Sir Augustus Franks, Lord Avebury, General Pitt-Rivers, and other leaders—in the Quarterly Journal of the Geological Society of London It has remained unchallenged for more than forty years, and has passed into the literature of anthropology *Res judicata est* The charge of forgery is not now to be made without clear evidence In answer to a letter asking for this evidence Prof Sollas writes to me that it is based on what he was told "some years ago, I think 1919," by a clergyman since dead, who declined to give names or other particulars. This means that the charge of forgery is founded on gossip without a shred of evidence, and is unworthy of further notice

The Cresswell horse is engraved in fine lines in a style similar to that of the figures of animals found since in the late palæolithic caves of France and Switzerland It is not accurately represented by Prof. Sollas in his Fig 299 This figure is copied from Evans's "Ancient Stone Implements" (2nd edition, p 524), in which my woodcuts were used If the copy be compared with the original it will be seen that the details have been omitted, leaving merely an outline useless for the study of the art of the caves.

Prof. Sollas is equally unfortunate in his sweeping statement that there is no attempt at art in the palæolithic caves of England. Our Committee is now at work at Cresswell, and Messrs. Garfitt and Leslie Armstrong have already recorded the discovery of incised figures of bison and reindeer along with other late palæolithic finds. As the work proceeds it will probably result in further proof that the picturesque gorge of Cresswell Crags was a hunting station of the artistic tribes who followed the wild animals in their migrations from the south of France into Britain, then the north-western region of the great Pleistocene Continent.

W. BOYD DAWKINS.

Fallowfield House,
Fallowfield, Manchester,
January 29.

The Ages of Peat Deposits.

THE wide interest now taken in the study of peat will, I think, justify further reference to the subject of Dr Pearsall's article in NATURE of December 6 and the letters from Mr. Tonks and Mr Forbes which followed on January 24 It is satisfactory to note that Dr. Pearsall has withdrawn from the obviously fallacious correlation he at first put forward He now, however, makes a second correlation based on the identification of the birch scrub on the peat-covered 25-foot beaches as Lewis's Upper Forest, making the latter Neolithic in age and therefore climatically in conflict with the evidence in the Pennines. This yields him the same result, namely, that climatic deductions from peat and forest beds are untrustworthy.

This second correlation, however, has no more to recommend it than the first. Mr Forbes will, I am sure, bear me out when I say that a few isolated occurrences of birch scrub at a low level are no proof of a forest period. On the contrary, the evidence of the submerged forests indicates that the period of greatest tree growth in the British Isles, *i.e.* Lewis's Upper Forest, antedates the 25-foot beach Dr. Pearsall will, therefore, have to try still another correlation if he wishes to establish his point

May I add to that of Mr. Tonks my appreciation of the admirable work recently done in the Pennines by Dr. Woodhead, Mr. Buckley, and Mr Holmes.

W B. WRIGHT.

Manchester

IN directing further attention to the question of peat deposits, Mr Wright seems to add little to the questions raised He accuses me, however, of basing a hypothesis on the occurrence of isolated patches of birch scrub. I have repeatedly (and publicly) expressed the opinion that the presence of timber in peat can have little significance unless the wood layer is continuous over a very wide area, and I have, indeed, criticised Lewis on the grounds that his "forest layers" did not always fulfil this condition. I may, therefore, be forgiven for finding Mr. Wright's accusation a little amusing It appears to me, however, that his criticisms can only be seriously urged by disregarding completely the use of the words "may" and "might" in my letter (although one of them is italicised), and by failing to attach any significance to the sentence which expresses the opinion that, on whatever they are based, these hypothetical correlations throw doubt on the climatic hypothesis of peat stratification. This is the gist of the letter, to which Mr. Wright's attention may be redirected.

W. H. PEARSALL.

The University, Leeds.

The Mortality of Plaice.

THE letter of Dr. G. P. Bidder in NATURE for January 31, p. 155, on "Constant Differential Growth-ratios and their Significance," raises the very interesting question: Are plaice potentially immortal? In other words, does senile decay occur? This might be decided directly by cytological investigation of old fish, but there is another indirect aspect of the question which my own work on plaice suggests as worthy of being brought forward in this connexion; namely, the differential death-rate of the sexes. Dealing with large collections from two regions, the North Sea and western part of the English Channel respectively, I showed (International Investigations Marine Biological Association, Report III. 1906–8 (1911)) that in each region males were more numerous than females up to the age at which the majority of males become mature for the first time, after which, or soon after which, females begin to preponderate, the number of males diminishing somewhat rapidly

Commenting on this phenomenon I said "The reason for the *rapid* decline in the relative number of males just after maturity might be somewhat obscure if only natural causes were at work. We know, however, that in the breeding season the catch of ripe males by trawlers greatly exceeds that of females on the spawning grounds; and it is possible, as Hefford suggests, that this factor may be the cause of the rapid decline in the proportionate numbers of this sex after maturity is reached" This artificial factor would, however, scarcely explain the whole result, nor would it account for the same phenomenon in the plaice of the Barents Sea, which was practically a virgin fishing-ground when Atkinson investigated it in 1907 and 1908 (Journal of the Marine Biological Association, vol 8, Nos 2 and 5) Then there are many cases of other species of fish and of other groups (cited by S W Geiser, *American Midland Naturalist*, vol. 8, No 7, 1923) in which the same thing occurs, and where there is apparently no suspicion of the unequal incidence in the two sexes of extraneous factors tending to the longer survival of one sex How then are we to account for the difference except by the lesser viability of males? This apparently implies natural death

Dr. Bidder also makes the interesting statement that "the ratio of ovary-weight to body-weight has no relation to age, but only to body-weight; in this as in some other respects, the age of a plaice is not measured by years but by the quantity of food which it has succeeded in assimilating." Among the "other respects" with which I am familiar from personal investigation I may mention the advent of maturity, which is apparently determined by size and not by age. Thus the plaice of the Barents Sea (see Atkinson, *ibid.*) are the same average *size* at first-maturity as the plaice of the central North Sea, but the average *age* at first-maturity differs very considerably owing to the much slower growth-rate of the Barents Sea fish (up to 1908 at least), due ostensibly to overcrowding and limited food supply. The same general cause would also account for the fact that while the average *size* at first-maturity of the North Sea plaice soon after the War (during the latter years of which restrictions on fishing produced overcrowding) was the same as in pre-War years, the average *age* at first-maturity was considerably higher.

WILLIAM WALLACE.

Fisheries Laboratory,
Lowestoft,
February 11.

Coal Resources of Alberta.

I SHOULD like to use the medium of your pages to ask that, when scientists and others sit in their offices or studies at home, to write about the resources of the outlying portions of the British Empire, they at least consult up-to-date and official reports on their subject. I hesitate even to suggest that they might restrain their pens either from modesty or from fear of ridicule when their information is only second-hand.

A case in point is a recent volume on "Fuel" in the "Resources of the Empire" series The description of the coals of Alberta, which have been estimated to constitute more than 60 per cent of the coal resources of the British Empire, is allowed only one and one-half pages out of the 63 pages in this section of the book The compiler takes most of his statements from a report published in 1913, and now much out-of-date But, to make matters worse, in a drastic condensation of the earlier report, he retains all or most of the mistakes and adds others The result is laughable to any one who knows anything of the subject

The Canadian Government at Ottawa has published many reports on the natural resources of the country, and the Scientific and Industrial Research Council of Alberta, during the past five years, has published ten reports on the resources of the province These reports are readily available in England, and requests for information receive attention There is therefore no excuse for the publication in England of out-of-date and incorrect statements

EDGAR STANSFIELD,
Honorary Secretary,
Scientific and Industrial
Research Council of Alberta.

Edmonton, January 30.

Pliocene and Pleistocene.

As you quote in NATURE of February 21, p 278, from a note of mine printed in No. 6 of *Natural History* (American Museum of Natural History), will you allow me to state that the note quoted was not submitted to me in proof by the editor of *Natural History* The part you quote embodies a serious misprint The words "distinguished by the marine 'Pliocene'" should read "distinguished by the name 'Pliocene.'" As I am writing further on the application of the terms "Pliocene" and "Pleistocene" to various deposits in East Anglia, I should like to remove at once this unfortunate misrepresentation of my views.

E RAY LANKESTER

Mercury Helide.

IN a recent note (NATURE, December 13, 1924, p. 861), dealing with the formation of mercury helide, mention was made of a plan which was being perfected for a quantitative analysis of the compound. The analysis has now been completed, with the result that 210·79 parts by weight of mercury were found in combination with 4·18 parts by weight of helium. Hence 200 6 parts by weight of mercury combine with 3·98 parts by weight of helium The simplest formula for the helide is therefore HgHe.

A detailed account of the work upon which this conclusion is based, will, I hope, be published shortly.

J. J. MANLEY.

Daubeny Laboratory,
Magdalen College, Oxford,
February 13.

The Control of the Tsetse Fly Menace.

By C. F. M. SWYNNERTON
(in charge of Tsetse work in Tanganyika Territory).

TSETSE-FLY problems may be divided into three —the problem of *G. palpalis* and the rain-forest tsetses, that of *G. tachinoides* and that of the savannah or "bush" tsetses belonging to the *morsitans* and *fusca* groups. These, as Major Church showed well in his recent article in NATURE, January 31, inhibit the development of vast areas in Africa, and members of the *morsitans* group are the carriers of Rhodesian sleeping sickness. It is to the control of the bush tsetses that I shall refer in this article (though the broader principles laid down would refer to all), and I shall describe in particular the methods and ideas that we are employing in our fight against them in Tanganyika. These may be understood best if I say that I have from the first felt that if we are to attack the tsetse-fly economically as well as effectively, we must do so in the main by the mere diversion and regulation of agencies already in existence—always, of course, with the fullest knowledge of and regard to the habits of the particular species we are fighting.

This implies that the natives would be taught to understand and take part in the solution of their own problems, and that natural agencies, such as grass-fires, flooding and exceptional seasons, would be harnessed. In a report to the Portuguese Government (*Bull. Ent. Res.*, vol. xi. pt. iv. pp 315-385) I laid special stress on the fact that "settlement properly planned will protect itself," on the utility of offering inducements to natives to settle in places, perhaps quite limited, where previous ecological investigation should have indicated that their presence will lead to control of the fly, on the part that European settlement on a sound agricultural basis might be made to play if clearing of the crucial spots were made a condition of occupation and the farms were small enough, and on the probable great value of postponing the annual grass-burning, usually worse than useless, to the end of the dry season (October), and then carrying it out under chosen conditions and in a thoroughly organised fashion.[1] I also emphasised the necessity for studying means of consolidating clearing or, in the absence of consolidation, the need, in a great fly-belt, for providing fly-proof barriers up to which to work; and, in a later report (*Bull. Ent. Res.*, vol. xiii., pt. iii. pp. 317-370), I sketched the scheme which has since been put into operation in Tanganyika Territory, and will be described briefly here.[2]

It should be noted, first, as regards "settlement properly planned," that the bushless cattle-areas of that Territory are, in very large part, "culture steppe," to borrow, provisionally, a German term. That is, they are kept free of bush and, thereby, of tsetse-fly, almost solely through the presence of sufficiently (not excessively) closely-dotted villages with their chopping for firewood, building and cultivation and the browsing of their numerous stock. On the whole, settlement and bush, man and fly, are sharply segregated. It is hoped that by encouraging this form of settlement in the far greater areas in which the natives *all* live dotted through the bush, pestered with tsetse and subject to other serious disabilities, we shall extend segregation and obtain what will be, for practical purposes, a control of the fly. This form of settlement—implying concentration of organisable labour, a safe base from which to extend, and a breeding centre for population which, being accessible, is capable of receiving assistance from us—is in any case a necessary preliminary to all measures of a large nature against the tsetse in the bush—that is to say, to *reclamation*. The production of it throughout the Territory will be gradual, and in certain parts it may prove to be impracticable, but appreciable success is already in places attending our initial propaganda.

Concentration accomplished and the natives in our new culture steppes assisted to become the possessors of cattle (for these are necessary in order to "anchor" them), it will remain for them to protect themselves against encroachment of the bush and the fly and to expand their fly-free grazing *pari passu* with the increase in their cattle. This, with tact and propaganda, will be done as we have already begun to do it in Shinyanga—through sheer clearing (as last year), for this appeals to the native, or better, through more discriminating measures which will be carried out by the people themselves under our guidance during a few days each year. Here I would say that our victory in Shinyanga lay not in our large clearing of ground—many people have cleared ground (and then let it go back to bush and tsetse)—but in the successful teaching of a native population to tackle its own problems. Stiebel, McMahon, Scupham are my administrative collaborators to whom the credit for this is chiefly due.

Thereafter, as population increases (and we would help it to increase by means of propaganda in hygiene), the scheme is that we should so guide the directions of expanding settlement as to bring into being coalescence, and thereby complete our fly-proof barriers and break off our blocks—the latter corresponding, let us say, in width with so small a fly-belt as that of Zululand. These, being of more manageable dimensions than our entire belt, would next be attacked individually in order to obtain final security and room for the freest development.

What methods are we to apply to the blocks? Lamborn's fine work in the breeding and release of parasites has been mentioned by Major Church. This, in places, might prove a useful contributory measure. Shircore, in an admirable little paper published in 1914, suggested, first, the concentration of attack on the dry-season centres of *G. morsitans* (which would first, he suggested, have been isolated by clearing from the rest of the bush and finally be cut down themselves); and, secondly, for the further controlling of the movements of the fly (which can be done, he considers,

[1] I based this recommendation primarily on more than fifteen years of experiment and observation as to the results on woody vegetation of grass-fires lighted year after year in different months, but suggested that deferred fires would also have the other effects—on the pupæ and as to the driving of the fly on the wing into unburning thickets, which would themselves gradually be destroyed—which I shall describe below. Shircore, in 1914, included grass-burning postponed to late July or August, for the clearing up and driving of any flies still scattered, amongst his measures of attack on the dry season centres of *G. morsitans*. Lloyd and Johnson have suggested that, long grass being inimical to breeding, the postponement of burning may be useful also for the prolongation of this unfavourable condition.

My experiments in Shinyanga will be described in detail in the *Bulletin of Entomological Research*.

even by narrow barriers), "the splitting up of fly-belts near villages and along main routes by forest destruction and burning." This, with the extension of agriculture, the clearing of villages and the attacking of the fly-centres, would ultimately, he thought, limit fly to areas which need not be entered by the natives. I doubt whether, short of such concentration of population as would produce "culture steppe," these measures could maintain safe segregation in any considerable belt; but they are thoroughly sound in principle and probably roughly represent a part of the means by which the relatively small belts of South Africa were unintentionally cleared of fly by the early settlers. Under such conditions I propose to use them freely.

Jack has experimented on a large scale in the destruction of game—but while, here and there, the checking of particular movements, large or small, of game animals may, if it is also feasible, be very necessary, no one wishes to exterminate our wonderful African fauna, a heritage of the Empire, of posterity, and of the scientific world, if we can control the tsetse otherwise. Our first results in Tanganyika lead to the very strong hope that we can, at least in the type of belt in which I have worked chiefly of late (Acacia-bush with *thickets* as the keynote to the fly's control, much like the fly-bush seen by me in Zululand); and suggest that we should wait a little longer before we commit ourselves finally anywhere to counsels of despair in the form of war against the game [3]

I have mentioned my own views already on the utilisation of man-power and the grass-fires and on discriminative clearing, and I think that the diversion of native energy and settlement—or European energy and cultivation where that is present—to the destruction and breaking up merely of the locally-important types of thickets, is likely to be a most valuable measure, because thickets are the chief breeding place of most species of tsetse and a refuge for all during fires. I am employing this already in conjunction with late grass-burning.

As regards the latter, I demonstrated last year (and, concerning certain points, many years previously) the correctness of the view stated in my Portuguese report, that postponed and organised grass-burning is capable, where the grass and the dry season are long enough, of destroying small woody growth and numbers of the smaller thickets, logs and (to judge from a comparative count obtained at Shinyanga) pupæ, and of driving the flies before the fire in great numbers into previously burned patches and such unburning thickets as are as yet uncleared. Our work suggested that in these places they can be exterminated (given the labour) by sheer catching on a great scale by hand and otherwise before they disperse. There can be little doubt also that by means of October grass-burning Father Cirvegna, a missionary in the Iringa district, has cleared of fly (*G. morsitans*), progressively but completely, an area a dozen miles in diameter in three burnings. The measure is not applicable everywhere.

[3] I may here correct an error that has slipped into a quotation of Major Church's from a conversation with myself—undoubtedly through my not making myself clear. It is by no means the whole of the Dar-es-Salaam district that is "gameless," and bush-pigs are present in any case. The point is that bush-pigs, by any methods now known to us, are, I believe, inexterminable in certain tsetse-infected types of woodland that cover great areas of Africa: and that, from observations made, I consider that these animals can alone support populations of fly sufficient to preclude the keeping of cattle.

An exceptional season appears to have been responsible for the disappearance of the fly in 1921 from some of the out-jutting portions of the Shinyanga belt. Had there existed fly-proof barriers between these and the main belt, they would not have been re-stocked. It is thus, and for the accentuation of the effect of late grass-burning, once this is installed as an annual custom, that I suggest that we shall "harness the exceptional season" for the clearing of some of our blocks.

Finally, the verification by Harris of views held by him (for example as to the possibility of isolating tsetses in particular pieces of bush until, as I understand it, they starve) is likely, when it comes, to help greatly.

I am experimenting also in Shinyanga as to consolidation of ground gained. We are offering inducements to natives to settle where their activities will be of use, introducing a rule that villagers should keep down young shoots from cleared growth round their villages, experimenting in the encouragement of the keeping of goats for their browsing, trying to induce people in culture steppe to dig up stumps for firewood rather than make journeys to the bush for it, and experimenting in cheap methods of killing woody growth. The encouragement given by our Department of Agriculture to the use of ploughs by the natives is helping me, for ploughing entails the removal of stumps, and we are diverting so far as possible large-scale cotton culture by means of ploughing to the actual ground I am clearing. The replacement of great thicket-areas by high forest (in this form, an idea of Fiske's), the safeguarding of roads, the means of reducing the carrying of fly into contact with cattle by man, and the testing of three important questions in connexion with the game, including its possible utilisation as an ally in our fight with the tsetse, are amongst the further experiments which are already in progress or contemplated.

In short, with the very hearty co-operation of the other Departments and of the District Administration, I have put into effect and, I think, begun to justify the view, that we can now best advance our knowledge of how to fight the tsetse by taking a definite large area or entire Territory and applying to it, without stint of necessary funds and labour, all ideas and knowledge that have been gained hitherto, and all further knowledge we yet shall gain, in a large-scale experiment in control by means (preferably) of reclamation officers working hand in hand with research officers. The latter are still needed for expert "survey," for the many points which will come up for investigation as we go along, and because, for economical and effective work, our knowledge of our flies' habits and habitats must be absolute; and, should funds become available, they will be needed in some numbers, in order that, as they master thoroughly the details of the problem and the work in the field (which it would take new men, unattached, some years to do), many may pass on from the earlier centres to other parts of Africa and assist in making the campaign general. Especially is needed a large fund to meet the various expenses of a scheme which shall provide for this gradual development of large-scale experimentation in actual control under all African conditions; that is, at the stage we have now reached, the right method of research.

The Phylogenetic Classification of Flowering Plants.

By JOHN PARKIN.

THE epithet, phylogenetic, in the above title might be considered superfluous, as all biologists are agreed that a taxonomic arrangement of any group of plants or animals should, so far as possible, follow evolutionary lines; after that, its convenience should be considered. Strange to say, up to the present, no arrangement of the Flowering Plants (Angiosperms), which has been generally adopted in text-books or used for floras, merits the term phylogenetic—hence the insertion of the word in the heading to this article.

Of the two chief classifications in use at the present time, that of Bentham & Hooker never outwardly professed to be a phylogenetic arrangement; while that of Engler, though apparently launched as such, has proved unworkable from the evolutionary point of view, and bears the impress of being artificial in its main contention, namely, the primitiveness of the apetalous unisexual flower of few parts. Surely, then, the time is ripe—some would say long overdue—for the introduction of a new system embodying up-to-date views respecting the evolution and possible origin of the flower. A strong movement in this direction is being taken by Mr J Hutchinson of the Kew Herbarium, and a series of papers by him, entitled "Contributions towards a Phylogenetic Classification of Flowering Plants," are appearing in the *Kew Bulletin*.[1] It is the purpose of this article to invite the attention of botanists to these papers, and at the same time to review briefly the general position and trend of this department of botany.

Kew has never adopted Engler's system. It has hitherto remained faithful to that of Bentham & Hooker as expressed in their classical work the "Genera Plantarum." But at last it shows unmistakable signs of breaking away and of inaugurating a new arrangement on logical lines. As it controls largely the systematic botany of the Empire, such a system is bound to make headway, so it is incumbent on those botanists who are interested and sympathetic to give it their attention and helpful criticism, in order that it may benefit thereby before it becomes too stereotyped. A new system cannot be fully worked out all at once. Hutchinson's method of publication by a series of preliminary papers gives ample opportunity for this kind of criticism, and we are sure that such comments will be much welcomed. He has already enunciated his principles and dealt in detail with some of the important families[2] composing the Ranales upon which his system is based, and last year he published his proposed rearrangement of the orders (cohorts) and families constituting the Archichlamydeæ of Engler (the equivalent of the Polypetalæ and Apetalæ combined of older classifications). These papers are not only worthy of the attention of the taxonomist, but also of the general botanist. They infuse new life into a department of botany which at times is apt to savour too much of the kind of material with which the systematist usually deals.

It is well to remember that, prior to the publication of "The Origin of Species," systematic botany was under the influence of the dogma of the constancy of species. Since systematists then adhered to the belief that the different forms of plants were special creations, the idea of primitiveness was not involved—it had no meaning. Consequently it was largely optional as to which group was given the initial place in a system. Two chief tendencies, however, are noticeable with respect to the Dicotyledons—one the placing of plants with incomplete flowers lacking petals (the Apetalæ) first, and the other, the putting of the Ranalean families (Ranunculaceæ, Magnoliaceæ, etc.) into this prominent position. One may be said to have culminated in the classification of Engler and the other in that of Bentham & Hooker. The former system in a measure owed its initiation to Brongniart, who in 1843 suggested that the apetalous division of Jussieu ought to be abandoned on the ground that these flowers are an imperfect state of polypetaly. This was a remarkable step forward on the part of this French botanist, considering it was ventured at a time when the principle of evolution was not generally accepted. The German school later, while putting into practice to some extent Brongniart's suggestion, *e.g.* in uniting the apetalous Chenopods with the petalous Caryophylls—the stock example—made no attempt to interpolate the whole of the apetalous families among the Polypetalæ; but instead diverged on novel lines by postulating, or at least inferring, the primitiveness of unisexual flowers of few parts, such as we find in the catkin-bearing trees and Casuarina.

Bentham & Hooker made no attempt to apply Brongniart's principle. They adopted the Candollean classification, modifying it in certain respects. De Candolle was the first to commence a dicotyledonous sequence with the Ranalean families, and Bentham & Hooker followed suit. They both treat the apetalous families as a sort of miscellaneous appendage, after dealing with the whole of the Polypetalæ and Sympetalæ. It is interesting to note that no phylogenetic significance was attached to the position assigned to the Ranalean families.[3] Intuitively they appear to have alighted upon the primitive group.

Hutchinson's aim is to reconcile, as it were, the two opposing systems at present in use, on one hand, by taking the Ranalean families as his base and, on the other hand, by making full use of Brongniart's principle. He considers such a system, broadly speaking, phylogenetically sound, and with this the present writer is in agreement.

Among British systematists Engler's system has met with tardy acceptance. The conservatism of Kew has probably been the restraining influence—a conservatism which now appears justified. In universities, however, it has by now been generally adopted, apparently without criticism. Doubtless Engler's great name, coupled with the publication in association with Prantl of that colossal, finely conceived and beautifully illustrated work "Die Natürlichen Pflanzenfamilien," which marks an epoch in botanical literature, prevailed upon botanists to accept the

[1] *Kew Bulletin*, pp. 65 and 241, 1923; pp. 49 and 114, 1924.

[2] Ranunculaceæ, Winteraceæ (detached from the Magnoliaceæ) and Annonaceæ.

[3] See, in this connexion, a letter dated May 13, 1907, from Sir J. D. Hooker to Dr. Newell Arber, reproduced in "Life and Letters of Sir J. D. Hooker" (Leonard Huxley, London, 1918, vol. ii, p. 22).

system. It appears to me to be a most difficult one upon which to frame a course of instruction in what is known, for want of a better term, as systematic botany. Perhaps, though accepted in the abstract, it is largely ignored in the class and lecture-room! But there is the self-taught botanist to consider, and he has only text-books on Englerian lines for his guidance.

Let us glance at the difficulties in the way of regarding Engler's system as even remotely phylogenetic. It is based essentially on the character of the perianth: the mere fact of relying on one organ for his sequence arouses suspicion as to its naturalness. He commences with families possessing flowers without a perianth or with sepals only, passes to those with a petaloid perianth, and then to those with a definite calyx and corolla There is no evidence of the perianth arising in this *de novo* fashion, as outgrowths from the floral axis, as presumably is the supposition. Besides this, we are committed to the difficulty of deriving the hermaphrodite from the unisexual flower. In both cases the evidence—and there is an abundance—points the other way, namely, that the absence of the perianth or of one set of sexual members is due to reduction. In regard to the catkin families (Amentiferæ) and the like, with naked or apetalous flowers, where obvious links with petalous hermaphrodite forms are not to the fore, surely it is simpler on circumstantial evidence to look upon these flowers as very reduced, than to view them as being primitive in character. Further, it is to be noticed that such flowers are grouped in dense and often complicated inflorescences—an arrangement which cannot be taken as primitive

A considerable controversy has centred around the supposed primitiveness of the Amentiferæ on other grounds than the character of the flower. This has arisen in part through Treub's classical researches on Casuarina published in 1891, and in part through the hope of deriving the Angiosperms from the Gnetales through this group. The Amentiferæ consequently received a considerable amount of attention, especially as regards the internal structure of the ovule. All attempts, however, to connect the catkin-trees with the Gnetales have proved abortive, or at any rate far from convincing. Treub's discovery of the peculiar way (chalazogamy) in which the pollen-tube penetrates the ovule in Casuarina, though hailed at first as a primitive character of prime importance, can now only be regarded as secondary and of little or no phylogenetic significance. The Amentiferæ may possess some primitive features in the ovule and in the structure of the wood, but they do not appear to have a monopoly of these. In one point the Magnolian group surpasses them, for certain of its genera lack vessels in the wood, and so are gymnospermous in this respect. It would thus appear quite feasible to regard the Amentiferæ as having come as an early offshoot from Ranalean stock along reduction lines. There is some evidence for their affinity with the Rosales generally, and with the witch-hazels (Hamamelidaceae) in particular. Hutchinson favours this view.

In certain quarters in which the Amentiferous flower has been accepted as primitive, the Ranalean flower has also been admitted as a primitive type. The logical outcome of such an expression of opinion would surely be to infer a polyphyletic, or at least a diphyletic, origin for Angiosperms. But there are grave difficulties in such an inference. At the present time I venture to think that the vast majority of botanists regard the Angiosperms as monophyletic; that is to say, an interrelated assemblage of plants which have arisen from one source. Apart from other considerations, one has only to dwell upon the unique type of embryo-sac and the same kind of stamen (microsporophyll) prevailing throughout the group to be convinced of this. Ruling out, then, the possibility of a mixed origin for Flowering Plants, the derivation of all forms of flowers from the Ranalean pattern,[4] especially as exhibited in Magnolia and its allies, would appear to be the only feasible one; thus affording a basis upon which to erect a phylogenetic, or at any rate a logical, system of classification.

The Monocotyledons have so far not been mentioned. Though various views have been held in the past regarding their relationship to the Dicotyledons, there is now a consensus of opinion that they have had a dicotyledonous origin. In other words, their ancestors possessed seedlings with two seed-leaves (cotyledons). How the monocotyledonous seedling with its single seed-leaf arose from the dicotyledonous one is still a matter of dispute. The Monocotyledons must perforce have branched off at a very early period, as the two groups are traceable back to rocks of about an equal antiquity

It is then on morphological rather than geological evidence that the dicotyledonous derivation of the Monocotyledons is favoured. It is difficult to interpret otherwise their peculiarities, such as the single cotyledon, lack of cambium and style of leaf Consequently, in a new system of classification which professes to be phylogenetic, they should follow, and not precede, as Engler has them, the Dicotyledons Hutchinson, I believe, intends to place them so. Two points now arise which affect their arrangement. Have they had a single or plural origin from the Dicotyledons? Though no precise answer can yet be given to this query, the present writer sees no cogent reason for regarding them as other than a natural self-contained group. Then it may be asked from what dicotyledonous assemblage of plants can they be derived? The floral features in common between some of the water-lily family (Nymphæaceæ) and the Helobieæ (water-plantain, flowering-rush, etc.) suggest something deeper than mere parallelism. It may not therefore be unduly straining affinities to derive the Monocotyledons from the Ranalean plexus The Helobieæ can then be treated as the primitive group, at any rate so far as floral features are concerned. The question of the origin of the Monocotyledons is largely bound up with that of the habit of their immediate ancestors Henslow, years ago, suggested an aquatic origin, and though this was seriously challenged by the late Miss Ethel Sargant in favour of a geophilous origin, it cannot yet be dismissed. The truth may lie somewhere between. Just as in the Dicotyledons, lines of both advancement and reduction with respect to the corolla (petals) can be traced. One of the former has ended in the Orchids, with their

[4] A hermaphrodite flower, in short, with its members indefinite in number, free from one another, borne spirally on a conical axis and arranged in a definite sequence on this axis, namely, proceeding from below upwards, first perianth members with no clear separation into sepals and petals, then stamens, and finally carpels.

extreme specialisation for insect-pollination, and one of the latter in the Grasses, well adapted for pollination by the wind. Disregarding the teleology, we believe there is a substratum of truth in the following lines:

They tell us that the homely corn that grows,
From russet stem and leaf, our daily bread,
Was once a lily; which by various steps
Of menial work, became degraded thus;
It left its high-born sisters in their robes
Of gorgeous idleness to clothe itself
In this plain dress for common household use.
Its bright-hued petals, nectar cup, and store
Of fragrance sweet, that insect lovers wooed,
It sacrificed; and only wandering winds,
That have no sense of beauty or delight,
Now woo its sober blooms with heedless sighs.
But for this noble humbling of itself
God has more highly honoured it, to be
The chief support of human beings, made
In His own image—rulers of the world.

(To be continued.)

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

10. HERMANN HELMHOLTZ (1821–1894), HEINRICH HERTZ (1858–1894), AND RÖNTGEN (1845–1923).

THE names of Helmholtz and Hertz remain connected together in my mind probably because, when I met them towards the end of their lives, the conversation with both mainly turned on the nature of cathode rays. Hertz adhered to the idea that they consisted of vibrations, while Helmholtz from the beginning stood up for the corpuscular theory, and was rather sore that the idea did not originate in his own laboratory. During the few months I was working there, at the end of 1874, Goldstein was engaged in the important researches which the Royal Society has recognised by the award of the Hughes Medal. His experiments, which showed that the rays emanating from a cathode were strongly repelled by an adjacent parallel electrode, were sufficient to convince Helmholtz that the rays consisted of a projection of negatively electrified matter, but Goldstein did not fall in with this view. "Of course," said Helmholtz to me a few years later, "as soon as Stokes became acquainted with Crookes's experiment he guided him into the right path."

In his early years Helmholtz seems to have been very sensitive to criticism. Roscoe used to relate how he found him once in great distress, complaining that his whole scientific career was endangered because some one had thrown doubt on one of his conclusions.

The Physical Laboratory of Berlin in 1874 contained only three or four rooms, with about a dozen students engaged in researches on a number of subjects mostly suggested by Helmholtz. In his daily rounds he used to discuss scientific problems freely with each in turn. He was as quick as Kelvin in being able to shift his mind quickly from one subject to another, but, in contrast with Kelvin, there was always a good deal of the *Grand Seigneur* in his attitude, and the title of *Excellency* bestowed upon him was borne with great dignity. He relaxed to some extent in his annual visits to Pontresina, where I received much encouragement from him in my early attempt to form some consistent theory of the passage of electricity through gases.

Her Excellency—his second wife, and a member of the South German aristocracy—was fond of society and gave weekly musical parties at their home in Berlin. She was of a highly strung and nervous temperament. During one of their visits to England they were staying with Roscoe at Manchester, and one morning she came down to breakfast complaining that she had been very ill during the night. She woke her husband, saying: "Hermann, I am going to die." "That is easier said than done," replied Helmholtz, turning round to sleep again. At one of his visits to Roscoe, he was accompanied by his daughter. The conversation turned on the possibility of flying. "It would be beautiful," said Miss Helmholtz; "one could escape so easily from one's chaperon; but then perhaps girls would be put into cages."

The intimate relations which Helmholtz maintained with Kelvin are referred to in the biography published by Königsberger. I may quote here the passage from a letter written by Helmholtz to his wife while on a visit to Lord Kelvin:

> "The former (James Thomson) has a good brain with clever ideas, but he will not listen to anything except about engineering and talks about it at all hours, day or night, so that no other subject of conversation has a chance in his presence. It is amusing to watch each of the brothers (William and James) insisting on explaining something to one another, and neither of them listening to what the other says. But the engineer is more persevering, and generally gets his own way.
>
> "In the meantime I have seen a number of new and ingenious appliances of William Thomson's, and had two interesting days here in consequence. But Thomson's thoughts follow each other so rapidly, that one can only obtain the necessary explanations about the working of his instruments, etc., by a series of questions to which it is difficult to get an answer. How his students can understand him is beyond me, as they cannot permit themselves to make the efforts to keep him to the point, which I could venture upon. All the same, a number of students were working in the laboratory and seemed to know what they were doing. . . . Thomson's experiments did for my new hat. He set a heavy metallic disc, balanced on a point, into rapid rotation, and in order to show me how the disc became immovable by the spin—he struck it with a hammer. The disc revolted against this treatment and flew off to one side, projecting the iron stand in the opposite direction. The stand split my hat and carried it away. The disc happily did no damage beyond breaking some glasses."

As is well known, the original suggestion that Hertz should undertake the experimental demonstration of the propagation of electrodynamic waves according to Maxwell's theory came from Helmholtz. The research could be undertaken only by one who possessed exceptional abilities both on the theoretical and experimental

[1] Continued from p. 306.

side. The merit of the execution belongs to Hertz alone. Towards the end of 1888, he communicated his first decisive success in obtaining waves of comparatively short length so that he could, by means of a parabolic mirror having an aperture of two metres, form a parallel beam and confirm previous results. Helmholtz wrote in answer: "I was much pleased with your latest feat. It concerns things at the possibilities of which I have nibbled for years in the hope of finding a hole by which to enter. I am therefore familiar with your line of thought, and its great importance is quite clear to me" In the same year Hertz had the choice of accepting a professorship at Berlin or Bonn, the vacancies occurring through the deaths of Clausius and Kirchhoff. Hertz decided for Bonn, and Helmholtz, approving the choice, writes: "Whoever is still able to carry out extensive scientific work is well advised to keep away from large towns" The great appreciation of Hertz's work by Helmholtz is shown by the unusual course he took in proposing the posthumous award of a certain prize to Hertz. He justified the proposal on the ground that it may "discharge a debt of the nation, inasmuch as Hertz during his lifetime had been much less honoured by his countrymen than by other nations"

In my own intercourse, I found Hertz to be a man of extreme modesty. During one of my visits to him, he received the news of some distinction the Academy of Sciences of Vienna had bestowed upon him. He seemed worried by it. "Too many honours," he said, "are as bad as too few. They do not add to the pleasure and only create jealousies" With regard to the fundamental question of cathode rays, he attached great importance to an experiment he had made, which showed that they could pass through gold leaf, and looked upon this as telling in favour of waves; to which I could not agree.

I am told that in early youth Hertz gave expression to weird ideas with regard to possible happenings if some of the ordinary circumstances of life were changed.

It is sad to think that the illness which led to his death was probably aggravated, if not caused, by the unsanitary state of his laboratory, which, as I am told, had been built and used as a hospital for certain contagious diseases.

The succession of experimental discoveries leading, through Hertz, to the important researches first of Lenard and then of Rontgen is well known. I never spoke to Röntgen, and hearing of his presence in another hotel during one of my visits to Pontresina, I called on him. He was not at home, but I saw his wife, who received me in a friendly manner. The call was never returned, though amends for this want of courtesy were made a few months later. Returning to Manchester from a short Christmas holiday at the end of the same year, I called at the laboratory on my way home from the station On looking at the accumulated correspondence, I opened a flat envelope containing photographs which, without explanation, were unintelligible Among them was one showing the outlines of a hand, with its bones clearly marked inside. I looked for a letter which might give the name of the sender and explain the photograph. There was none but inside an insignificant wrapper I found a thin pamphlet bearing the title "Über eine neue Art von Strahlen," by W. C. Rontgen. This was the first authentic news that reached England of the discovery of the so-called X-rays. I sent a translation of the paper to NATURE, where it appeared on January 23, 1896.

Obituary.

SIR EDWARD THORPE, C.B., F.R.S.

ALTHOUGH Sir Edward Thorpe had been unwell for some considerable time, yet his well-known energy and virility were so remarkable that it came as a shock to his many friends to learn that he had passed away on Monday, February 23, at his beautiful Devonshire home by the sea, Whinfield, Salcombe. It was an ideal residence in his retirement, for he could there enjoy his favourite relaxation of yachting, and take any one of his three yachts out to sea for a sail just as readily as taking a walk, which the hilly roads and paths of South Devon had latterly rendered a matter of difficulty for him.

Carrying my mind back to the year 1885, when I had already been two years as a Royal Exhibitioner at the Royal College of Science, South Kensington, I remember the gratification with which we students learnt that our retiring professor of chemistry, Sir Edward Frankland, was to be succeeded by Prof. Thorpe, whose reputation at the Yorkshire College, Leeds, had gone before him. I had previously studied under Sir Henry Roscoe at the Owens College, Manchester, where Dr. Thorpe had held his first appointment as demonstrator on Sir Henry's staff, and this fact, together with a personal introduction to the new professor from the latter's father-in-law, Dr. John Watts, proved a bond of attachment, which, after my third year as student, but working in the research laboratory, led to collaboration with Prof. Thorpe in several years of research on the oxides and other compounds of phosphorus, and to a demonstratorship and lectureship which lasted eight years, indeed, until Sir Edward, in 1894, left South Kensington to become Principal of the Government Laboratories

Sir Edward was born in the Harpurhey suburb of Manchester on December 8, 1845, his father, Mr George Thorpe, having been a merchant of that city. At the close of his student days at the Owens College he went to study under Bunsen at Heidelberg, carrying with him a letter of introduction from Prof. Roscoe, who had himself been a pupil of Bunsen. Moreover, young Thorpe was entrusted with a present from Roscoe to Bunsen, namely, some well-formed crystals of potassium and sodium, which Roscoe had placed in separate bottles under rock-oil, as usual with the alkali metals. In the throes of packing, the young student economised space by placing both metals in one of the two bottles, the crystals being sufficiently different to be distinguishable. After presenting his letter, he duly brought forth the bottle, removed its paper covering, and ceremoniously presented it to Bunsen as containing unique specimens of potassium and sodium crystals. The great chemist looked hard at the bottle and then at his visitor, who then first realised that something was wrong. For, instead of metallic crystals beneath the rock-oil, there

was nothing but a shining liquid resembling mercury. He was beginning to fear that the great master would suspect a practical joke, of doubtful taste, when suddenly Bunsen's face lighted up with a great smile, and he told the would-be new disciple that his first research should be the investigation of this new liquid; he then welcomed him heartily to Heidelberg. The sequel revealed no joke, but the important new fact that sodium and potassium unite to form an alloy, which is liquid at the ordinary temperature, and closely resembles mercury in appearance.

While at Heidelberg, Thorpe had Victor Meyer for both laboratory companion and lodgings partner, so that the well-known great friendship between them dates from that time. After taking his Ph D. degree, Thorpe spent a short time in the laboratories of Bonn, after which he returned to Manchester and took up his duties as demonstrator under Roscoe

In the year 1870 two important events occurred in Thorpe's career, namely, his first professorship in chemistry, at the Andersonian College, Glasgow, and his marriage to Caroline Emma, the daughter of Dr Watts, chairman of the Lancashire and Cheshire Institutes and of the Manchester School Board, and one of the ablest of the pioneers of higher education. In 1874 came the call to the newly established Yorkshire College, Leeds, where he made the chemical department renowned for its efficiency and its output of original research. His painstaking and highly accurate determinations of the specific volumes of liquids of definitely related chemical composition, involving new and refined modes of determining their densities and thermal expansions, led to very important conclusions concerning chemical constitution, and he was elected a fellow of the Royal Society in 1876

On taking up his appointment to the chair of chemistry at South Kensington in 1885, Thorpe suggested to me a research on the oxides of phosphorus, especially with the view of identifying, or if necessary of discovering, the lower oxide, supposed to be P_2O_3 This oxide had really not hitherto been isolated, for the supposed descriptions of it turned out eventually to be quite absurdly erroneous. The professor's first instruction, however, was one which greatly impressed itself at the time, and one which might with great advantage be more generally followed in commencing a research: it was to spend several days in studying and abstracting all the known literature on the subject, from both books and original memoirs.

This research extended over six years, and resulted in the publication of four joint papers. The first paper, published in the Journal of the Chemical Society in 1886, concerned an altogether new oxide of phosphorus, the tetroxide P_2O_4, which we obtained in excellent crystals instead of the expected P_2O_3 for which we were searching The second paper was published in the same journal in 1890, and described the isolation and eventual successful determination of the constitution and properties of the so-called trioxide It proved to be a white waxy solid, melting to a colourless liquid at summer temperature (22° C), and boiling, in an inert atmosphere, undecomposed at 173°, and affording a vapour density which indicated precisely the double formula P_4O_6 and not P_2O_3. The third paper, also in the same journal, was published in 1891, and described a number of interesting reactions and additive compounds of the new phosphorous oxide. The fourth paper gave further details of one of these addition compounds, phosphorus sulphoxide, $P_4O_6S_4$, in preparing which on several occasions very lively and dangerous explosions occurred, one of which left the nearest of us on the floor This fourth paper was contributed to the newly projected *Zeitschrift für anorganische Chemie*, being the first paper in the first number published (February 27, 1892) of that journal.

One of the most satisfactory things about the results of this research was the establishment of the fact, by the kind collaboration of the late Sir Lauder Brunton, that the oxide P_4O_6 was the cause of the necrosis of the jaw from which workers in match factories so frequently suffered. The knowledge gained in the research was eventually the means of entirely avoiding the production of the oxide during the manufacture of matches, and consequently brought about the total disappearance of this terrible disease

During his tenure of the chair at South Kensington, Sir Edward Thorpe carried out the determinations of the atomic weights of gold and silicon, in collaboration with Dr. A. P. Laurie and Mr Young respectively; and also a prolonged research on viscosity with Mr. J W. Rodger, which formed the subject of the Bakerian Lecture to the Royal Society in 1894. The wonderful delicacy and dexterity of manipulation manifested in these researches was even more fully exemplified in the research on the atomic weight of radium, which was carried out by Sir Edward at the Government Laboratory, and formed the subject of his second Bakerian Lecture in 1907. He also carried out at South Kensington researches on some volatile fluorine compounds in collaboration with Mr. Rodger and with Mr. Walter Kirman.

A further important research of a totally different kind was the magnetic survey of the British Isles, which Sir Edward commenced while at Leeds and continued when at South Kensington, in collaboration with Sir Arthur Rücker, who was similarly transferred from Leeds to South Kensington as professor of physics. The writer has some special knowledge of the immensity of this work, as he made the computations and maps for the first survey, that of Scotland. Sir Edward Thorpe's yacht was of great assistance in this part of the work, especially as regards the stations on the west coast, and among the isles. His love of the sea was also the cause of his taking part in four solar eclipse expeditions, those of 1870, 1878, 1886, and 1893. The first proved unduly exciting, for H M.S. *Psyche*, carrying the members of the expedition from Naples to Sicily, was totally wrecked.

After sixteen years at the Government Laboratory, Sir Edward returned to South Kensington as professor of general chemistry at the Imperial College of Science and Technology. He finally retired at the close of the War with the title of emeritus professor. He had been knighted in 1909, after receiving the C.B. in 1900. He was the recipient of a Royal Medal from the Royal Society, of which he was foreign secretary from 1899 to 1903, and was the first Longstaff medallist of the Chemical Society, of which he was president (after being for a number of years treasurer) from 1899 to 1901. He received honorary degrees from several

universities at home and abroad, and was an honorary member of a great number of learned societies throughout the world. He was president of the Society of Chemical Industry in 1895, and in 1921 of the British Association at its meeting in Edinburgh. This last occasion saw the beginning of his illness, for he was taken ill on arrival in Edinburgh, and was unable to deliver his presidential address on atomic structure, which was read for him by Sir Alfred Ewing.

It is only possible in the space left at my disposal to mention briefly Sir Edward's brilliant lecturing and literary ability. His early books, "Chemical Problems," "Inorganic Chemistry," "Quantitative Analysis," and "Qualitative Analysis," were used by thousands of students, while his great "Dictionary of Applied Chemistry," now appearing in a new edition, is a monumental work of the utmost importance to industrial chemistry. His biographies of Dr. Priestley and Sir Humphry Davy, the "Essays in Historical Chemistry," and his "History of Chemistry," are most readable and entertaining, as well as of scientific value, giving the personal touch which is so charming to the wonderful events in the evolution of modern chemistry. Finally, his "Yachtsman's Guide to Dutch Waterways" and "The Seine from Havre to Paris" are permanent records of a master yachtsman and valuable guides to later comers in the yachting world, whether their vessels be propelled by wind, steam, or petrol

Sir Edward Thorpe thus passes from our ken in his eightieth year, full of honours as of years, and with a published record of scientific work which it is given to few scientists to achieve He leaves no children, so that our sympathy will therefore go out in all the greater measure to his lifelong companion, Lady Thorpe, who has so devotedly watched over and cared for him, and made his home a paradise.

A E H. TUTTON

MISS L. S. GIBBS.

MISS LILIAN SUZETTE GIBBS, the news of whose death at Santa Cruz, Teneriffe, on January 30, came as a shock to her botanical friends at home, had done good work both as an investigator in the laboratory and as an explorer in many parts of the world. After a two years' course at the Swanley Horticultural College, she entered the Royal College of Science as a student in the Department of Botany under Prof. J. B. Farmer. From that time onwards her life, which might have been one of leisure, was devoted to the pursuit of science. She became a research student at the College, and the value of her work was attested by the award of the Huxley medal and the prize for research in natural science.

Miss Gibbs became early interested in the floristic side of botany, and collected in the Alps of Switzerland and Austria. In 1905 she visited South Africa with the British Association and collected in Southern Rhodesia and at the Victoria Falls. But her great contribution to floristic botany was her work on the mountain flora of various parts of the world. Between 1907 and 1915 she visited successively the mountains of Fiji, Mt. Kinabulu in British North Borneo, the Arfak Range in Dutch North-west New Guinea, the Bellenden-Ker Range in Queensland, and the mountain plateaux of Tasmania. Each of these expeditions formed the subject of a memoir—published in the Journal of the Linnean Society, the *Journal of Botany*, or the *Journal of Ecology*—in which she described her observations on the plant-formations, discussed questions of distribution of plant-life, and gave a systematic account (with the assistance of experts in some of the groups) of the very considerable collections which she brought back. A complete set of these collections is in the Department of Botany of the British Museum, where her floristic work was elaborated. She retained, however, her interest in structure and development, and her papers in the *Annals of Botany*, especially one on the development of the female strobilus in Podocarpus, based on her own collected material, are valuable contributions to this aspect of botany.

Miss Gibbs was a woman of strong personality, and keenly interested in the question of equal rights for her sex. She was one of the earliest women fellows of the Linnean Society and the Royal Microscopical Society, and was also a fellow of the Royal Geographical Society. She had many friends, who deeply regret that her work is finished, and to whom her death comes with a sense of personal loss.

THE world of geography has sustained a serious loss by the death of Mr John Bolton, which occurred after half an hour's illness on February 22. Mr. Bolton was in his eighty-third year, having been born in 1842 In 1857 he entered the service of Mr Edward Stanford, the grandfather of the present head of the firm of Edward Stanford, Limited, and although of recent years he had only acted in a consulting capacity, his connexion with the firm was continuous until his death Many leading cartographical works were produced under his direction, including the London Atlas series of maps, Stanford's 6-inch and 4-inch scale maps of London, and their series of library maps In 1884 Mr Bolton was appointed geographical expert to the Congo conference at Berlin, and in 1897 served on the Venezuela Boundary Arbitration, being loaned by the firm to the government for such service He was a life member of the Royal Geographical Society, and attended regularly the meetings of the Geographical Section of the British Association, including the visit of the Association to South Africa in 1905 He was also a fellow of the Royal Colonial Institute In the course of his career Mr. Bolton had been associated with many famous men, including General Gordon, H M. Stanley, Cecil Rhodes, Lord Kitchener, Capt. Scott, and Sir Ernest Shackleton. He possessed a personality that inspired confidence, and a geniality that endeared him to all with whom he came in contact.

WE regret to announce the following deaths.

Dr. Adolph Kemna, corresponding member of the Zoological Society of London and formerly president of the Royal Zoological and Malacological Society of Belgium and of the Belgian Society for Geology, Palæontology and Hydrology

Dr. C. Symes, president in 1897 and 1898 of the British Pharmaceutical Conference, on February 13, aged eighty-five.

Dr. A. de Watteville, for many years editor of *Brain* and distinguished for his work on the nervous system, on February 24, aged seventy eight.

Current Topics and Events.

Two subjects of philosophical and physical investigation have excited deep interest during recent years, the theory of relativity and the theory of quanta. These were discussed by Dr. J. H. Jeans in his Kelvin Lecture on "Electric Forces and Quanta," delivered on February 5 at the Institution of Electrical Engineers, and published as a special supplement to this week's issue of NATURE. The first part of the lecture deals with electric forces in the light of the theory of relativity, and it is claimed that, as all the phenomena go on as though there were no ether, the conception of an ether is superfluous If an ether does exist, it must probably be thought of as a four-dimensional structure and must be largely subjective. The generalised geometry of Einstein and Weyl can predict and explain all the systems of forces of the universe, both gravitational and electrodynamical But geometry does not explain the atomicity of electric charges or the essential difference between positive and negative electricity Again, quantum theory indicates the existence of discontinuities in Nature of a kind not contemplated in the older mechanics No one is better qualified to deal with the implications of this theory than Dr Jeans, whose report on radiation and the quantum theory published by the Physical Society of London has long been a mine of information for those interested in the subject Some of the ideas adumbrated in the final chapter of that report have now been developed further It may well be that the atomicity of the quantum theory is only another aspect of the atomicity of electric charges The quantum theory represents, perhaps, a quality of the four-dimensional continuum, which is somehow analogous to the scaliness of a crocodile skin This is equivalent to the suggestion that the "calamoids" or four-dimensional tubes of force of Prof. Whittaker should be regarded as quanta Our conception of the action of an electric field on an electron seems to require revision in the light of a recent hypothesis due to Einstein. The electric forces in Maxwell's equations serve in some way to measure the *probabilities* of jumps in the velocity and perhaps also in the position of an electron in an atom.

THE numerous statements that have been made recently by politicians and others about the great economies that could be effected by erecting very large electric generating stations are sometimes very misleading to the public. It is pointed out that, by the use of these super power stations, the cost of the coal used per unit of power generated would be halved. It is generally concluded, therefore, that the cost of power to the consumer would be reduced by a half When we remember, however, that only from 20 to 25 per cent. of the total cost of generating a unit is due to the coal used, it will be seen that the reduction of price to the ultimate consumer would only be about 12 per cent, and not the 50 per cent. which the public have been led to expect. Similar conclusions apply to water power. We have received from the Smithsonian Institution of Washington an excellent report, by S. S. Wyer, on the power possibilities and preservation of Niagara Falls. It is pointed out that the erection of the requisite hydro-electric plant is less than half that of the total scheme. Few realise that about 80 per cent. of the cost of delivering the energy to the resident consumer is incurred after the power has left the generating station The money used for carrying out an enterprise, whether state-owned or not, must ultimately come from individual owners, and they have an obvious right to receive a hire or rental for it. An interesting comparison is made between the systems adopted on the Canadian and on the American side of the Falls. In Canada the Government owns about 79 per cent of the hydro-electric system. The service in Ontario is not taxed, so that the lowering of the cost to the consumer is done at the expense of the tax-payers of the districts in which the property is located. On the American side, about 10 per cent. of the price of the service has to be paid for taxes. The rate of recession of the crestline of the Canadian Falls, which carry 94 per cent. of the water, is about 5 feet per annum. On the American side it is only about 2 inches per annum. Methods of preserving the scenic beauty of the Canadian Falls and preventing them from "gradually committing suicide" are discussed.

A STEP, which may eventually be one of far-reaching importance, has recently been taken by the authorities of the London School of Hygiene and Tropical Medicine. They have appointed a Rhodesian Research Fellow in the person of Dr. G. R. Ross, at present lecturer in the University of Leeds and a former graduate of the University of St. Andrews. This development is the direct outcome of the co-operation which existed between the Government of Southern Rhodesia and the old London School of Tropical Medicine whereby, on two occasions, Dr. J. G. Thomson, Director of Protozoology at the School, visited Southern Rhodesia and carried out research work in connexion with blackwater fever. The results of Dr. Thomson's useful inquiries have appeared in the form of a well-illustrated monograph, a pioneer publication. Dr. Andrew Fleming, the Medical Director, Southern Rhodesia, felt, however, that this was merely a beginning and that the question of blackwater fever, and indeed of other tropical maladies, was so important from the point of view of the white settlers and of the general development, not only of Southern Rhodesia but also of the whole chain of Central African tablelands, that measures should be taken to ensure a continuance of such research work. He found his Government in a sympathetic mood and, together with Sir Francis Newton, the High Commissioner of Southern Rhodesia, he approached the Board of Management of the London School of Hygiene and Tropical Medicine after some preliminary discussions with the Director of the School. Eventually it was arranged that, for a period of three years, the Southern Rhodesian Government, in addition to making an annual grant

towards the expenses of the Field Station, would undertake to provide laboratory accommodation and equipment together with travelling expenses in Rhodesia for one or more research workers to be appointed and sent out by the London School. In accordance with this arrangement, Dr. Ross, accompanied by a trained laboratory assistant, will leave England in March.

SIR OLIVER LODGE's fifth broadcast talk from the London Broadcasting Station 2 LO on "Ether and Reality" was delivered on Tuesday, March 3. His subject was "Electromagnetism. How Radiation is Generated." An electron at rest has nothing magnetic about it; but the path of a moving electron is surrounded by magnetic lines of force, as an umbrella might be surrounded by indiarubber rings When the electron is suddenly stopped, these rings are "shocked" off, spreading out as a pulse or shell of radiation with the speed of light, carrying away the energy and momentum. A moving electron has additional mass when stopped, this mass disappears as a quantum of radiation; the size of the quantum depending on the previous speed. There are strange unexplained facts looming ahead of us Sometimes, Sir Oliver said, we feel as if radiation were a half-way stage between ether and matter. Matter is discontinuous. Is light discontinuous? Is light a kind of matter which is bound to travel at a fixed speed, unless perchance it be modified into an electron? The difficulty and the interest of the problems before us are only equalled by the ingenuity with which they are being attacked. The eternity of the cosmos seemed at one time in doubt by reason of the dissipation of energy. now there is some glimpse of a way out. Matter tends to fall together gravitationally, but radiation tends to spread to the confines of the universe, and however diluted it retains its vigour What becomes of the quanta? Why is no speed greater than that of light possible? Some revelation is dawning upon us, and confronted with a majestic vision of reality, we—like those other explorers on their first view of the Pacific Ocean—have

"Look'd at each other with a wild surmise—
Silent, upon a peak in Darien."

SIR JAMES C. IRVINE in his discourse on Friday evening, February 27, at the Royal Institution, dealt with sugars from the point of view of the organic chemist. Within the last fifty years many new sugars have been isolated from natural sources; others, unknown in Nature, have been prepared synthetically; formulæ have been ascribed to them, and in many cases the structure has been determined. In order to make further progress, a new phase must be entered upon when only such reactions of the sugars will be studied as proceed under conditions approaching closely to those which obtain in the living tissues; conditions which will not admit of the use of solvents or reagents inimical to life, and in which the optical, electrical and thermal factors will be rigidly controlled. Above all, new types of synthesis are required, and only when the chemist resolves to regard it as a crime to conduct a sugar-reaction at the boiling point is there any real hope for sugar chemistry. Eighty years ago Faraday was investigating the electrical properties of cane-sugar, and the recollection inspires the hope that the research now associated with the Royal Institution may again be applied to the whole series of carbohydrates. What a prospect is opened up when a well-founded conception of constitutions based on both physical and chemical evidence shall have been acquired.

AT the forty-seventh annual general meeting of the Institute of Chemistry held on March 2, the president, Prof. G. G. Henderson, after referring to the loss sustained by British chemistry by the death of Sir George Beilby, one of the past presidents, announced that the Council had invited the co-operation of the Society of Chemical Industry and the Institute of Metals, of which Sir George had also been president, in establishing some fitting memorial in his honour. The Institute was frequently invited to appoint delegates to participate in public inquiries Such invitations were welcomed, but the Council had felt obliged to give expression to a mild protest that provision could not be made to lighten the sacrifice of time and expense which the duties of such representatives entail. The Council was diffident about asking fellows who were resident in the country to attend Government committees at their own cost and without emolument. The attitude of authorities towards scientific men had been reflected in the speeches of Ministers of the late Government, who apparently regarded the professional scientific man in the civil service as a very useful person in an ancillary or subordinate position, but it should be insisted upon that scientific departments should be controlled by competent scientific men. Chemists who were also capable men of affairs were available, many such held high positions in industry, and they were coming more and more into positions of control. It was the business of the Institute to ensure the supply of such chemists for the benefit of the country The following officers for the year ending March 1926 were elected *President*, Prof G G. Henderson; *Vice-Presidents*, Prof. E. C. C Baly, Mr E R Bolton, Mr. A. Chaston Chapman, Dr T Slater Price, Prof. A. Smithells, Mr. E W. Voelcker, *Hon. Treasurer*, Mr. P. H Kirkaldy. At the conclusion of the formal business, the president, supported by Prof Thomson, made a presentation, on behalf of the fellows and associates, to Mr. Richard B. Pilcher on completing thirty years as secretary and twenty-five years as registrar and secretary of the Institute. In the evening the Council entertained Mr. and Mrs. Pilcher and their family to dinner at the Hotel Russell, followed by a reception.

ON February 28, at 9.23 P M., a strong earthquake was felt in the eastern United States and Canada. The first accounts do not suggest a shock of unusual or destructive intensity, but it is possible that its importance was not fully realised at the time the messages were sent. Two facts in the brief reports seem to indicate the severity of the earthquake. One is its great duration, even supposing that the estimate

of four minutes at New York was much exaggerated The other is the magnitude of the disturbed area. An earthquake that was noticeably felt in New York, Richmond (Virginia), Louisville (Kentucky), Chicago, and Montreal must have disturbed a district at least 750 miles in diameter and containing not less than 450,000 square miles, that is to say, an area greater than that affected by the San Francisco earthquake of 1906 At New York the movement was strong enough to break the writing pointer of the seismograph at Fordham University. It was recorded at West Bromwich and, no doubt, at many other places in Europe

AN important conference upon applied microscopy is to be held in Sheffield on April 20 next and following days under the auspices of the Royal Microscopical Society at the invitation of the University of Sheffield, the civic authorities, the Master Cutler, and the loca technical colleges and research associations A local committee has been appointed representative of the academic and industrial research interests, and the programme includes a large number of communications and discussions dealing with technical problems connected with iron and steel, wood, coal, paper, textiles, industrial diseases, and microscopical optics Visits to works and laboratories are being arranged, and an imposing exhibition of instruments and apparatus will be open throughout the meeting. It is also hoped to arrange with the railway companies to grant cheap travelling facilities to those attending the conference The conference is open to all interested in technical microscopy, and full particulars can be obtained from the Secretary, Royal Microscopical Society, 20 Hanover Square, London, W.1, or from the Local Secretary, Mr E J. Thackeray, Dept. of Applied Science, University of Sheffield.

THE fifth International Congress of the History of Medicine will be held at Geneva on July 20-25, with Dr Charles Greene Cumston as president and Sir D'Arcy Power as president of honour The following papers among others will be read medical operations in the stone age, by M. Eugène Pittard of the University of Geneva, Albert von Haller and the "Disputationes chirurgicae selectae," by Sir D'Arcy Power, Robert Whytt, an eighteenth-century neurologist, by Dr John D. Comrie, the history of typhoid fever in the child, by Prof. P Gautier, a letter of Tronchin and the Suttonian method of inoculation, by Dr J G. de Lint, Voltaire and medicine, by Dr. J D Rolleston, goitre at Geneva in the Middle Ages, by Dr E. Wickersheimer, Lavater and his successors, by M Fosseyeux, a note on the history of diagnosis in medicine, by Dr. F. G Crookshank, a letter of Girolamo Fracastoro on poetry, by Dr. J. W. S. Johnsson of Copenhagen, historical researches on the history of anatomy in the Ateneo Romano, by Dr. P. Capparoni, medical literature of the seventeenth century as exemplified in the Elzevir Press, by Dr. E B Krumbhaar, hygiene and public health in the early civilisations, by Mr C J. S Thompson; the origin of veterinary art, by Sir Frederick Smith; the history of magic in the cure of disease, by Prof. Jeanselme; Martin Luther and his noises in the ear, by Prof. G. Bilancioni; a medical congress at Rome in 1681–82, by Dr. C. G. Cumston; and Benjamin Waterhouse, an American pioneer, by Dr J. W. Courtney. Further information can be obtained from the general secretary of the Congress, Dr. A. de Peyer, 20 Rue Général Dufour, Geneva.

THE new journal entitled *The Industrial Chemist and Chemical Manufacturer* constitutes a somewhat novel departure in the sphere of chemical journalism, because it will be the only monthly publication of its kind in Great Britain, and because it is very attractlively got up The general style resembles that of some American journals which contain articles profusely illustrated and advertisements very effectively displayed. It is interesting to note that in the new publication the advertisements of many old-established firms that have, apparently, never been radically changed within living memory, appear in an entirely new dress—the designs and the letterpress being entirely novel In the journal proper the main feature is the large number of articles, many of which are written by well-known authorities. Among the subjects treated are vanadium, saccharin, power alcohol, petroleum refining, glass, disintegrating mills, lime, vegetable adhesives, disinfectants, and adhesives. The manner of treatment may be described as not severely technical, the object being to attract and interest not only the chemist, but also those employed in or associated with chemical undertakings, including the works' manager and the directorate, who may have no expert knowledge of chemistry. This is a field which has hitherto been neglected or inadequately cultivated, and in extending a welcome to the new publication we express the hope that it will be particularly successful in fulfilling this part of its programme.

ON Tuesday, March 10, at a quarter past five, Prof. E. N da C. Andrade will begin a course of two lectures at the Royal Institution on the evolution of the scientific instrument, and on Thursday, March 12, Dr. Leonard Hill will deliver the first of two lectures on the biological action of light. The Friday evening discourse on March 13 will be delivered by Prof. Gilbert Murray, on the beginnings of the science of language, and on March 20 by Prof. J. W. McBain, on soaps and the theory of colloids.

APPLICATIONS are invited by the Board of Management of the Christie Hospital, Manchester, for the post of cancer research worker, whose duties will be to carry out research work on the blood in cancer. Candidates should have a medical qualification and experience in clinical, pathological, and biochemical methods. The latest date for the receipt of applications, which should be sent to Dr C. Powell White, Christie Hospital, Manchester, is March 13.

AT the annual general meeting of the Physical Society held on February 13, the following officers were elected. *President*, Mr. F. E. Smith; *Vice-Presidents (who have filled the office of President)*, Sir Oliver J. Lodge, Sir Richard Glazebrook, Dr. C

Chree, Prof. H. L. Callendar, Sir Arthur Schuster, Sir J. J. Thomson, Prof. C. Vernon Boys, Prof. C. H. Lees, Sir W. H. Bragg, Dr. Alexander Russell, *Vice-Presidents*, Dr. E. H. Rayner, Dr. J. H. Vincent, Dr. D. Owen, Mr. C. R Darling; *Secretaries*, Prof. A. O. Rankine, Imperial College of Science and Technology; Mr. J. Guild, National Physical Laboratory, Teddington, Middlesex, *Foreign Secretary*, Sir Arthur Schuster, *Treasurer*, Mr. R. S. Whipple, *Librarian*, Mr J. H. Brinkworth.

THE series of Early Chellean hand-axes found during 1924 by Mr. Reid Moir upon the foreshore, and in a deposit representing the base of the Cromer Forest Bed, at East Runton and elsewhere on the Norfolk coast, is now being exhibited in the Museum at Ipswich, and the specimens can be examined by any one desirous of doing so The early flint implements of East Anglia are now arranged in the following sequence, which illustrates the succession of human cultures in Late Pliocene and Early Pleistocene times, namely, (*a*) specimens of Harrisonian eolithic type, (*b*) pre-Chellean forms from beneath the Red Crag, (*c*) Early Chellean hand-axes from the base of the Cromer Forest Bed, and (*d*) Chellean, Acheulean, and Mousterian implements from various deposits in Suffolk and Norfolk

THE Soviet Government of Russia has taken steps to protect the *zubr* or European bison, and incidentally other rare forms of life, in the Western Caucasus, by declaring an area of about 250,000 dessiatins, or approximately 625,000 acres, a reserved area under the control of a special official with the title of *zubrovni zapoviednik*. Within this area " all activities damaging the natural relief of the surface, such as the felling of timber, pasturing of cattle, opening of quarries, etc.," are forbidden.

THE Cambridge Instrument Co., Ltd, have issued a new list, No 194B, dealing with thermoelectric pyrometers. The catalogue deals in succession with general principles, indicators, recorders, thermocouples, cold junction control, and pyrometer tester. The latter is a compact form of potentiometer suitable for checking the accuracy of any type of thermoelectric potentiometer. An interesting item is the new thread recorder, which is enclosed within a robust moisture and fume-proof metal case instead of the customary teak cabinet Recorders of this type are supplied making up to six records on one chart. These may include records of temperature, carbon dioxide percentage, and carbon monoxide percentage It might be remarked that the carbon monoxide indicating apparatus is a development of the carbon dioxide type The amount of carbon monoxide is obtained by a differential measurement of the carbon dioxide present before and after the flue gases are passed through a small electric furnace containing copper oxide which converts any carbon monoxide present into carbon dioxide

ERRATUM.—The words " on the Use of Preservatives and Colouring Matters in Food " appearing on p. 222, col. 2, of the issue of February 14, in the concluding sentence of the review entitled " The Chemistry of Flour Milling," were inserted in error after the author had passed his proof The Report of the Departmental Committee already published makes no reference to the bleaching and improving of flour, but a further report will appear in due course.

Our Astronomical Column.

THE DISTANCE OF THE ANDROMEDA NEBULA.—There have been several very discordant estimates of the distance of this object. A new one has now been made by Prof. Hubble, and is briefly described in *Popular Astronomy* for February. He has found several Cepheid variables in the nebula, determined their periods, and deduced their absolute magnitudes in accordance with Prof. Shapley's formula The resulting distance of the nebula is 950,000 light years, a distance which would make it of the same general order of size as our galaxy.

This is probably a more trustworthy estimate than those previously made; a possible correction might arise from absorption of some of the stars' light in traversing the nebulous matter.

A note in *Popular Astronomy* points out that the 7th magnitude Nova that appeared in the nebula in 1885 would at this distance have been 140 million times as bright as the sun.

ANNUAIRE DU BUREAU DES LONGITUDES, 1925.—This little handbook is now very well known, and contains as usual, a large amount of useful information —astronomical, meteorological, physical, geographical, political, etc

The special essays this year are by M. E. Fichot on the effect of the earth's rotation on the tides, and by M. G. Ferrié on the use of lamp valves in wireless telegraphy and telephony, with applications to astronomy. A little more care would seem to be called for in editing the astronomical tables: p. 289 gives the revolution of Mercury 2 days too great, a very serious mistake, p 302 in giving the elements of Neptune's satellite omits to notice the very interesting variation in its orbit plane

The information about the comets of 1923 is not up-to-date, much better elements of comet 1923 *a* were available months ago The object described here as comet 1923 *b* was found to be a minor planet more than a year ago. there are, moreover, three misprints of proper names in the account of it, " Harward," " Seegrave," " Crowford ", p 310 gives the erroneous period 12·1 years (more than a year too short) to Tuttle's comet This mistake has been repeated for several years and has misled many people. This period was deduced from a short arc, and was not intended to be taken as accurate

UNION OBSERVATORY, CIRCULAR 62.—This circular, dated last June, contains a number of important observations, which include the transit of Mercury (third contact 24 seconds before Nautical Almanac, fourth contact 35 seconds before), also long series of observations of Reid's Comet 1924*a* and Eros, which were too far south for European observers; also 114 occultations of stars by the moon, observed in 1923, which are fully discussed. There are reproductions of the spectra of Nova Aquilæ on 21 days, June 11–August 10, 1918, which are conveniently arranged for studying changes The identity of the Nova with a 10th magnitude star in the Algiers astrographic catalogue was independently detected by the blink microscope at Johannesburg.

Research Items.

PREHISTORIC POTTERY IN PERU.—Messrs A. L Kroeber and D. D. Strong, in a study of the pottery from Ica collected by Dr. Max Uhle for the University of California some years ago, pay a well-deserved tribute to the valuable but too little recognised work of this archæologist in South American, and especially Peruvian, archæology In the case of the pottery from Ica now described in University of California Publications in American Archæology and Ethnology, vol 21, No 3, and in the case of the pottery from Chincha, of which an account by the same authors appeared in a previous issue, they find that their independent study completely corroborates Dr. Uhle's suggested classification and sequence in all important respects The pottery from graves in the Ica Valley, which lies on the coast of southern Peru, is classified into seven periods, as against the three at Chincha, representing more or less successive culture phases—Inca, late Ica II. and I (corresponding closely with the three phases at Chincha), Middle Ica II. and I, Early Ica or Epigonal, and Nazca or Proto Nazca The last named is unique and distinctive in colour, design, and shape The stylistic development from Middle Ica I to Inca is so continuous that when once Inca is accepted as latest, any other sequence is impossible The Ica Epigonal and Middle Ica are undoubtedly related to Tiahuanaco style, but it is difficult to see that Epigonal represents a decadence of Tiahuanaco styles as Uhle supposes

THE THEORY OF SENSE DATA.—In a lecture published in the Journal of the Royal Astronomical Society of Canada, Dr H H Plaskett expounds what he calls the descriptive view of science This is the view that the objective content of science consists exclusively of the data of sense, that these sense data are not subjective aspects of reality but the actual non-mental content of the scientific object itself which is a construct of them, that the metaphysical concepts of substance and cause have no place in science, which can quite well dispense with them, that the atoms and molecules of physics and chemistry are not real existents but concepts Dr Plaskett seems to have taken this view from the chapter on sense data in Hobson's Gifford Lectures and to find support for it in Pearson's "Grammar of Science" The first of these does not profess to be original, but gives an excellent account of the recent controversy aroused in philosophical circles by the new realism of Mr. Bertrand Russell and Dr. Broad If Dr Plaskett had gone directly to the origin of this theory in modern times, Mach's "Theory of Sensations," he would probably have been aware of some difficulties of his descriptive view of science which are unnoticed in his lecture. Mach found, in fact, that, try as he would, he could not get scientific objects out of sense data, they are not implicit in them, and yet only as sense data do scientific objects exist for us at all Mach spurned metaphysics, and he put forward as the only alternative to a scepticism like Hume's a theory of psycho-physical parallelism. This for him was the only possible way of objectifying scientific knowledge The ideal of a science of pure description, renouncing all explanation, is no new thing It goes back at least to Bacon, but it has never proved satisfying to the restless spirit of scientific inquiry. Since Berkeley, the problem of perception has made it still more disconcerting. It is well, however, that we should be continually reminded of the initial difficulties, even the paradoxes, which surround the problem of the true method of scientific procedure.

CUTTING SEED POTATOES.—Potato growers frequently hesitate to cut their seed potatoes on account of the uncertainty as to the yield per plant and to the growth and healthy development of the cut sets This second point has been investigated by J. H. Priestley and G. C. Johnson (Journ. Min. Agric 31, No 11), who indicate the precautions needed to eliminate this uncertainty. The healing of the cut surface of a tuber is brought about by the deposition of a suberin deposit, which forms a barrier to the entry of moulds and bacteria capable of attacking and rotting the tuber. If the potato is cut in moist air this suberin layer is continuous over the whole surface, but if the air be dry the suberin is patchy and organisms are able to penetrate through the cracks between the patches, thus damaging the tuber Field trials have proved the importance of this fact. Similar tubers of Great Scott were cut and exposed to sun and air for 24 to 48 hours, or kept in a damp, warm place for the same time. Much heavier crops were obtained with the latter treatment, 15½ tons against 6½ tons, 23½ tons against 14½ tons, etc, similar results being obtained with other varieties in other districts Apart from the question of yield, it appears that the certainty of growth from cut sets is much greater if precautions are taken to protect the sets from sun and wind after cutting before they are planted.

OBSERVATIONS ON HOOKWORM LARVÆ.—Dr L Fabian Hirst describes (*Ceylon Journ. Sci*, Section D, Medical Science, vol 1. pp 1-26, 1924) investigations on the epidemiology of hookworm disease in Colombo His attention was directed to the problem in consequence of a severe outbreak of hookworm dermatitis and disease amongst coolies handling soil from certain trenches in a field used for the disposal of septic tank sludge The larvæ of Ancylostoma, Necator, and Strongyloides exhibit aerotropism, *i e* they attach themselves by one end to some fragment of fibre or similar substance on the surface of the soil and extend the rest of their bodies into the air, constantly moving as if in search of some additional support The movement of Strongyloides larvæ is more jerky and gyratory; the hookworm larvæ exhibit a slow undulating motion. The author figures an apparatus in which buckskin leather is employed as a means of bringing about a separation between penetrative larvæ (which pass through the buckskin into a warm solution on the other side) and others present in the soil The species of the penetrative larvæ (Ancylostoma and Necator) can be definitely determined only after development to the sexually mature form in the intestine of a suitable host In laboratory experiments the author found that larvæ of *Necator americanus* could be recovered from the surface of infected soil for at least 108 and up to 124 days Larvæ lived about three months in water and fluid extracts of trench soil; they died much more rapidly in soils and fluids kept at blood heat than in the same media at room temperature.

GROWTH IN INDIAN MOLLUSCS.—In an account (Records, Indian Mus., vol. xxvi. pp 529-548, Nov. 1924) of his observations on growth in Indian molluscs, Major R. B. Seymour Sewell deals with five freshwater species and four marine brackish-water species—all gastropods except one (*Mytilus variabilis*) He examined 212 examples of *Pyrazus palustris*, which occurs in abundance in Nankauri Harbour, Nicobar Islands, in a swamp which is submerged at high water, and found that correlated with the gradual increase

in size is a remarkable change in the character of the radula. So marked is the difference between the radulæ of the smallest and the largest specimens that one might reasonably doubt whether they belong to the same species In the smallest individuals, having a height of about 12 mm., the radula consists of rows of teeth—seven in a row (dental formula 2 1.1 1.2), each tooth possessing several cusps. As growth proceeds the cusps on the teeth become gradually reduced in number until finally the central tooth presents only a single median cusp, the lateral tooth has a single cusp and a trace of a second one, and the two marginal teeth have a single cusp with traces of one or two small ones. The reduction seems to be brought about by a process of fusion rather than by suppression, and, so far as can be ascertained, is not correlated with any change in the habits of the mollusc. No corresponding change occurs in the other gastropods examined

BLACK SHEEP.—Wensleydale sheep have white wool, but the skin of the face and ears is deep blue, and this colour may extend to other parts of the skin Breeders select for a maximum amount of pigment. The breed produces about 15 per cent. of black lambs, together with a number which are "pale blue" and very occasionally one which is pure white Mr F W Dry, from breeding experiments (*Journ Genet.*, vol 14, No 2), concludes that the black is a simple recessive, since blacks bred together give only black offspring The same is true of blacks in certain other breeds of sheep The blue-faced sheep are found to be heterozygotes analogous to the Blue Andalusian fowl, in other words, a black sheep with a (dominant) white coat On the other hand, the Karakul sheep is a dominant black When crossed with white breeds, the lambs are pure black Such F_1 hybrids are now widely bred and their fleeces used as fur, but in the adult the colour becomes grey or dirty white In black Welsh mountain sheep the colour of the coat and horns is also apparently dominant in crosses Mr. J. A. Fraser Roberts (*Journ Genet.*, vol 14, No 3) describes experiments with this breed A pattern known as "badger-face" also occurs, which is white with black markings on the face, belly, and legs This appears to be recessive to both black and white In crosses between black and badger-face a white lamb has been known to appear Such cases of "reversed dominance" have been recorded in other breeds. Their further investigation is a matter of much genetical interest. The badger-face marking has also been studied by Wriedt in a Norwegian breed of sheep. Individuals with reversed badger-face markings, *i.e.* black where white should appear and vice versa, are also known to occur

NEW PLANT ILLUSTRATIONS.—Two numbers of *Curtis's Botanical Magazine* have recently appeared under the energetic editorship of Dr. Stapf, being parts i. and ii. of vol. 150, each containing plates of eleven plants, and each including one rhododendron and one primula, *R. bracteatum* and *P. Bulleyana*, in part i., *R. glischrum* and *P. melanops* in part ii. Other interesting plants in part i. include *Stellera Chamæiasme*, an example of a small genus of Thymelaceæ that has not previously figured in the *Botanical Magazine*; *Lindmania penduliflora*, a Peruvian example of this genus of Bromeliaceæ which may be in Nature an epiphyte like so many of the family, although the immediate allies of this plant grow on the ground on the edge of the forest; and a species of the cactus-like genus of the Senecioneæ, *Kleinia stapeliiformis*. Part ii. includes some very striking plants, notably an epiphytic member of the Vacciniaceæ *Agapetes speciosa*, with brilliant scarlet flowers; a species of an Orobanchaceous genus, *Æginetia indica*, successfully raised at Kew as a parasite upon the roots of the sugar cane, which will apparently only grow upon the roots of monocotyledons, and a shrub from Natal, *Ochna serrulata*, with yellow flowers and very striking fruits, in which the blue-black drupelets stand out against a vivid background of vermilion-coloured, enlarged sepals.

FOSSIL CRANE FLIES FROM SOUTH AMERICA.—Two species of crane flies have been discovered by G R Wieland (*Amer. Journ Sci.*, 9, Jan 1925, p 21) in the Rhætic beds of Minas de Petroleo, south-west of Mendoza, Argentina. The larger (*Tipuloidea rhætica*) had a wing spread of 2·6 inches, so that it rivalled in size the Australian "robber fly." The smaller form (*Tipulidites affinis*) had a wing spread of half an inch. This discovery emphasises the great antiquity of the Diptera

UINTACRINUS IN THE CHALK OF WESTERN AUSTRALIA.—Remains of the free-swimming crinoid, Uintacrinus, have been found in the chalk of Gingin, Western Australia (T H. Withers, Journ Roy Soc. W. Australia, 11, 1924, p 15) This discovery gives important evidence of the age of the Gingin Chalk, since Uintacrinus is characteristic of the lower part of the Marsupites zone of the Upper Chalk. It also shows that this crinoid, hitherto known from Utah, Kansas, England, and Westphalia, had a very wide geographical distribution

THE DOLDRUMS OF THE NORTH ATLANTIC.—The *Marine Observer* for February contains an article on "The Doldrums of the North Atlantic" by Mr C S Durst The author gives credit to Maury and Toynbee for their full discussion of this interesting region Toynbee's discussion was carried out with the perfection of minuteness, comprised by elaborate charts and voluminous letterpress It has the advantage of being based chiefly on the results from sailing ships, the observations being gathered by the Meteorological Office. An attempt has been made at a further discussion which may be of scientific value, but with the present-day steam vessels the region for the sailor has lost much of its "torment" Fig 3 (p 21), to which the author attaches considerable importance, is at least for the first ten days open to considerable doubt so far as the northern and southern boundaries of doldrum in March 1923 are concerned, and the resulting width of doldrum certainly is not 600 miles as given in the text

ICE IN THE BALTIC SEA.—Among a number of interesting publications on various aspects of Baltic meteorology and oceanography published by the Havsforsknings Institutet of Helsingfors a particularly detailed paper deals with the occurrence and distribution of sea-ice during the winter of 1920–21 (No 22, Isarna Vintern, 1920–21) The observations, which were gathered at coast stations and Finnish lightships, are given in full and entered on a series of coloured maps for the Gulf of Bothnia, the Gulf of Finland, and the Finnish water of Lake Ladoga. These charts show the beginning of the ice in the north of the Gulf of Bothnia in early December and its gradual extension southward. In the year under review the waters of the Aland Archipelago were not blocked until late January, but soon after that date fast ice extended across to the Abo Archipelago and the coast of Finland and remained until early March. The period of greatest extension of ice in the Gulf of Finland was the middle to the end of February, when, as usual, the Gulf was more or less entirely blocked In early April the southern coasts of Finland were clear, while the western coasts cleared between the beginning of April and the middle of May. These dates appear to have been earlier than usual. This

and other publications of the Institute are in Swedish, with very brief German summaries.

SPARK IGNITION.—A knowledge of the conditions under which an electric spark in an explosive mixture of gases will initiate an explosion is of great importance in the mining, motor, and other industries, but the results of experiments made hitherto have been inconclusive. In a communication to the *Philosophical Magazine*, which appears in the February issue, Mr. J. D. Morgan gives an account of his experiments on the igniting powers of inductance sparks in direct and alternating current circuits, and comes to the conclusion that the thermal theory of ignition is sufficient to cover all the known facts. According to this theory, it is necessary to raise a sufficient volume of the gas in the immediate neighbourhood of the spark to a sufficiently high temperature before ignition results, and if both conditions are not satisfied the flame produced in the gas immediately in contact with the spark will not spread. To satisfy them a certain minimum energy must be imparted to the gas in a fixed short time, and this is in general more easily done by a capacitance than by an inductance spark, but there is no difference between the effects of the latter when in direct or in alternating circuits. The cooling effect of the electrodes is very marked and must be taken into account.

TESTING PHOTOGRAPHIC PLATES.—The February number of the Journal of the Royal Photographic Society is devoted to the first session of the Conference on the Standardisation of Plate-testing Methods which was held at the Society's house on December 9. The papers read and the discussions on them are given in full. The subjects treated of at this meeting were (1) the light source, primary and secondary, (2) the exposure mechanism, (3) the development. The first paper is from the National Physical Laboratory and deals with standards of light. Of the standards at present available for sensitometry either the crater of the carbon arc or a gas-filled tungsten lamp, operating at a colour temperature of 2950° absolute, is recommended, but in either case definite specifications of details would have to be prepared. Dr. Helmuth Naumann gives a formula for a colour filter in gelatine which contains six different dyes, and changes the light from a vacuum tungsten filament lamp into "daylight" from about 3000 Å.U. to about 7000 Å.U. with sufficient accuracy for most photographic purposes. It seems generally acknowledged that the intermittency error caused by rapidly revolving sector wheels placed in the path of the light should be eliminated. With regard to development, it is argued on one hand that this should be uniform, and, on the other hand, that uniformity would not be fair, because different plates need different treatments to get the best results of which they are capable. In all, ten papers were read and discussed.

THE γ-RAY SPECTRA BY THE CRYSTAL METHOD.—M. J. Thibaud has recently described experiments, in which the frequencies of monochromatic γ-rays are arrived at by converting the radiations into β-spectra, by means of the photoelectric effect on different elements, and measuring the energies of the electronic streams emitted. In the *Comptes rendus, Acad. Sci. Paris*, of January 12, he describes how, using de Broglie's method, with a rotating crystal of rocksalt and photographic registration, he has been able to make measurements with angles α of reflection scarcely more than a fraction of a degree. The velocity of rotation was less than 1° in twenty-four hours. Glass tubes containing 40 mgm. of radium bromide in equilibrium with its products were employed, and also a preparation of mesothorium. The spectra consist of clear sharp lines, with no continuous bands, and the following values have been found for radiothorium or mesothorium.

No.	Int.	λ in Å.	Energy in volts.	Origin.
1	strong	0·168	73,500	—
2	"	0·145	85,000	Rd Th
3	weak	0·062	198,000	"
4	medium	0·052	236,000	Th B

The indirect method gives 233,000 for the energy in volts of a γ-ray from thorium-B, which agrees with No. 4 above within the limits of probable error; this line has been found by Meitner and by Ellis. Fräulein Meitner assumes a γ-ray 0·146 Å. to explain the β-radiation of radiothorium, which agrees with No. 2. The origin of No. 1 is not explained. Rays with energies of 273 and 298 kilovolts found by the indirect method, but weaker than the 233 kilovolt ray, have not as yet been observed directly. The spectrum obtained with radium confirms the two lines found by Rutherford with α about 1° 30′.

TYPOGRAPHIC INKS.—The technology of printing inks is described by Dr. N. F. Budgen in the *Chemical Trade Journal* for January 23. Typographic inks (used for book-printing, labels, etc.) are softer and thinner than lithographic inks, which must be unaffected by water. The essential constituents of printing inks, apart from the pigment, are the oil (usually linseed, though soya-bean, perilla, and other oils are often used), and the varnish (largely made from rosin oil). Cheap inks contain varnish made from mineral oils. The pigments used for obtaining different coloured inks and the incorporation of the ingredients are described in detail. Cheap black inks contain carbon black. More expensive inks use a black made from rosin oil.

SUGAR INDUSTRY IN GREAT BRITAIN.—The English beet-sugar industry is described in an article in the *Chemical Trade Journal* for January 23. The first factory to be erected in England was put up near Maldon (Essex) about 1832. It did not continue long, and the next factory, erected at Mount Mellick, Queen's County, Ireland, in 1851, also closed down at an early date. A works put up at Lavenham, Suffolk, in 1868, closed down ten years later; it was recommenced in 1885, but only worked for a few weeks. The primary cause of these initial failures seems to have been lack of beet, which the farmers would not produce in sufficient quantities. The more recent schemes are mentioned. The Cantley factory (near Norwich) was opened in 1912; it was closed during the years 1914–1920, but since the latter date it has operated each season. The old and modern methods of refining beet-sugar are described; the modern bone charcoal filtration method does not appear to be used in England. Some possible developments in the sugar industry are described in *Chemistry and Industry* for January 23. The article is mainly concerned with the use of vegetable charcoal for refining purposes; it is more economical than bone charcoal. One such charcoal is "suchar"; whereas a factory turning out 200 tons of raw sugar daily requires about 600 tons of bone black for refining purposes, the same factory would require only about 30 tons of "suchar." It is claimed that this reduces the cost of refining by one half. The "suchar," after it has been used twice, is washed and revivified by passing an electric current through it. This burns off the impurities without impairing the activity of the carbon itself. Glucose can now be obtained in a colourless crystalline form on a large scale; it is marketed as "ceralose." Crystalline fructose has also been obtained on a laboratory scale under conditions which make the transference of the method to the manufacturing scale almost certain of success.

Physiological Standardisation.

THE use of substances in the treatment of disease has, probably in a majority of cases, been empirical for some time after their discovery and adoption; in fact, in spite of recent advances in chemistry, through which the actual structure of many drugs has been elucidated, pharmacology is in many instances only able to describe the actions of drugs on living tissues without at present finding it possible to give the actual reasons for these actions The problem is part of the wider one of the relation between chemical structure and physiological action. In those cases where the chemical structure is known, it is easy to investigate the action of known quantities of the drug upon a number of organisms of the same or different species and thus arrive at the minimum dose which is effective, and at the maximum dose which is safe, for no drug is absolutely harmless when the dose has exceeded a certain specific limit. But when a substance cannot be isolated in a pure state and its chemical structure is unknown, as is the case for example with the active principles obtained by extracting certain glandular organs, the sole indication of their presence being the effects they produce upon living tissues, it is essential, to get comparable results with different samples and to protect the patient against a possible overdose, to have an approximate idea of the strength of the sample in terms of its physiological action. It is a common experience to find that extracts prepared in the same manner and containing a known amount by weight of the original organ, may yet differ enormously in physiological activity This variability is due to variations in the condition of the gland before extraction and to varying loss of the active principle during this process

To illustrate the methods used in physiological standardisation, those employed in assaying the active principle or hormone of the posterior lobe of the pituitary gland, commonly known as pituitrin, and that obtained from the pancreas, called insulin, may be described briefly, with special reference to recent work on the subject.

Pituitrin acts as a stimulant to smooth muscle, affecting the muscle fibres directly, its main effect on intravenous injection is to raise the blood-pressure, but after administration per os, or intramuscularly, its absorption is too slow to produce this effect, and yet it will cause contraction of the uterus, an organ the contractile power of which is due to the smooth muscle in its wall. In clinical medicine it is used chiefly for the latter purpose in the later stages of labour Methods of assay have been based on its effects on the blood-pressure and on the uterus Dale and Burn (Medical Research Council Report, No. 69) have given a detailed account of the latter: the uterus of the virgin guinea-pig is used as the test object, and an extract of the posterior lobe of the pituitary, prepared in a certain manner, as the standard It would be convenient to use as standard a substance of known composition which could be obtained in a pure condition, having the same stimulant action on smooth muscle as pituitrin. Unfortunately, tests with histamine and potassium chloride showed that uteri varied in sensitivity to these substances and to pituitrin independently.

Hogben, Schlapp, and Macdonald (*Quart. J. Exp. Physiol.*, 1924, vol. 14, p. 301) have recently described a method of assay based on the rise of blood-pressure produced by intravenous injection. It is not yet certain that the principles producing rise of blood-pressure and uterine contraction are the same, but a trustworthy method of assay of the former should be useful. Hitherto, the difficulty has been that successive doses of pituitrin produce a diminishing rise, or even a fall, of blood-pressure, and therefore samples cannot be compared with certainty In part this is due to the presence in the extract of a substance causing a fall of pressure; this can be removed by alcoholic extraction of the gland extract, or its formation prevented by placing the gland in cold acetone, as soon as it is removed from the body. Apart from this, however, frequent injections of a depressor-free extract produce diminishing effects until a complete immunity is obtained. This can be obviated by spacing the injections at wider intervals The test object recommended is the spinal cat, and the extract must be depressor-free, since it is possible that the substance which causes a fall of pressure in the anæsthetised animal causes a small rise in the spinal preparation If a dose which is about half the maximum, and produces a rise of pressure of 55 mm. Hg, is injected every hour, a 10 per cent. discrimination between two samples is perfectly possible, since the effect of the previous injection has worn off in this time. The chief objection to the method appears to be in the time taken, since injections are only possible every hour, the guinea-pig's uterus, on the other hand, can receive five or six separate doses in this time A further difficulty is that the preparation may vary slightly in sensitiveness during the course of an experiment, but this may be overcome by comparing the unknown only against adjacent injections of the standard.

The standardisation of insulin is an even more complicated problem Its effect is to enable the tissues to utilise more carbohydrate both in health and in diabetes, when the pancreas is diseased, the simplest observation to make which shows this increased utilisation is an examination of the sugar of the blood, which falls after a dose of insulin But if it falls too much, unpleasant symptoms, including convulsions, are produced

Macleod and Orr (*J Lab Clin Med*, 1924, vol. 9, p 591) have described in detail a method for assaying insulin based on the fall in blood sugar in rabbits. Owing to the variability in the response of different animals, a number must be used in any single test, the conditions must also be standardised so far as possible since the level of the blood sugar is influenced by many factors, thus the animals must be starved for the preceding 24 hours, must not have a blood sugar much above 0 1 per cent, and must not be used for more than two or three months, when they become refractory and put on weight At least four estimations of the blood sugar are necessary in each animal, and the time occupied is considerable, hence a simpler method, if as accurate, would be preferable, and Margaret Cheadle (*Austral J. Exp Biol and Med. Sci*, 1924, vol 1, p. 121) has utilised the incidence of convulsions as a method of assay In this case mice are used as test animals, and minute doses of insulin injected, and the incidence of convulsions in each group injected with the same dose noted After injection the animals must be kept at body temperature, otherwise they do not regularly develop convulsions. If a mouse unit of insulin be defined as the amount necessary to give convulsions in 60 per cent. of animals after subcutaneous injection, it must be correlated with the present standard, which is based on the fall of blood sugar in a rabbit, one unit being defined as the amount necessary to lower the blood sugar of a 2-kilo. rabbit to 0·045 per cent. in 5 hours. The unit used clinically is $\frac{1}{4}$ of the rabbit unit. The author finds 167 mouse units equivalent to 1 rabbit unit.

This somewhat cumbrous method of expressing the strength of insulin is necessary if comparable results are to be obtained in different tests with animals of varying weight A further complication has been found, in that some samples of insulin seem to contain a substance which may be described as an anti-insulin. de Jongh (*Biochem Jour*, 1924, vol 18, p. 833) gives an account of its properties: its presence is only revealed when small doses of insulin are injected, as in rabbits, but in man its influence appears to be small. It is apparently of a protein nature, and as the purification of insulin in the process of manufacture has been made more complete, the samples on the market at present appear to be free from it. In any case it is an illustration of the difficulties encountered by those who have to measure the strength of substances of unknown composition and isolated only in an impure condition

Heterogeneous Equilibria.

THREE papers by Mr. J. A V. Butler, in the Transactions of the Faraday Society, February 1924, and two in the *Phil Mag*, October and November, deal with problems of equilibrium at the boundaries between solids and liquids, and between two solids. The methods of statistical mechanics are applied in each case, and the first paper, "Conditions at the Boundary Surface of Crystalline Solids and Liquids," well illustrates the way in which other problems are dealt with

A diagram shows how the attractions of the solid and of the liquid on a molecule of the solute and their resultant are assumed to vary with distance from the surface, with a balance point at which the two opposing forces are equal A molecule from the surface will escape if, owing to thermal agitation, it has sufficient kinetic energy to carry it past the balance point Molecules which reach the balance point from the interior of the liquid are attracted to the surface. An equation is deduced, similar to that of Langmuir, for the number of molecules reaching the boundary surface of a gas with kinetic energy greater than a certain quantity λ This equation, which contains the mean collision frequency, applies to the molecules moving in the liquid towards the surface, but not directly to the molecules in the surface, the only motion of which is a vibration about an equilibrium position The mean collision frequency is replaced in the equation for these molecules by a vibration frequency ν

An expression for the solubility is thus obtained which leads to the le Chatelier-van 't Hoff equation for change of solubility with temperature, one of the terms of which is the heat of saturated solution. Assuming that ν is the characteristic vibration frequency of the solid, as determined by *rest strahlen*, and that the work done by the molecules from the surface layer, per gram molecule, in reaching the balance point is equal to the total heat absorbed in solution, unless this is less than the latent heat of fusion, when the latter is used, the author applies his equation to the alkaline chlorides. In this way he obtains results which are of the right order of magnitude.

Similar methods are employed in a discussion of the E.M.F produced when a metal is dipped into a solution containing its ions. The process is regarded as essentially a solubility phenomenon. In the solution of a salt crystal, made up of positive and negative ions, both kinds are dissolved, but it is assumed that in the case of a metal, only the positive ions pass into solution, while the electrons which go to build up the crystal lattice are left behind. Equilibrium is attained when equal numbers of positive ions are dissolved from and deposited at the surface in unit time. The negative charge due to the free electrons left on the metal retards the solution and assists the deposition, and to this extent the phenomena of salt solution are modified. This is taken into account in the mathematical treatment of this case, with the result that a formula is obtained for the potential which, in form, resembles that of Nernst. Instead of being based on osmotic pressure, however, it depends on the heat absorbed in the passage of the metal ions into solution, and on quantities defining the statistical conditions The values calculated from the formula are again of the right order of magnitude

In a third paper Mr. Butler proposes a kinetic theory of reversible oxidation potentials at inert electrodes dipped into a solution containing two substances related by a simple oxidation reduction process An expression is obtained for the numbers of each of the two ions, M′ and M″, contained in the solution adsorbed by each square centimetre of the electrode, using a mathematical method similar to that applied above The reaction between each of these ions and the electrode is considered, one of them tending to gain an electron and the other to lose one, and an expression for the oxidation potential is obtained This is determined by the ionisation potential corresponding to the loss of an electron by the reduced molecule, the difference in the energies of hydration of the two substances, the thermionic work function of the metal and two statistical constants

Mr. Butler deals with metal contact potentials in a paper in the *Philosophical Magazine* for October. He obtains an expression for the potential difference at the surface of a single metal in a closed space containing an electron atmosphere, the loss of electrons from the surface of the metal being balanced by the gain of electrons from the atmosphere He then considers the case of two metals in the electron atmosphere, but not in contact, and finds that though the surface P.D. of each metal depends on the electron atmosphere *concentration*, the difference for any two metals is characteristic of them If the metals are brought into contact, the conditions at the surfaces not in contact are unaltered, and if there is to be no continuous flow across the junction, there must be a P.D. at the junction equal to the intrinsic P.D of the metals. The Peltier heat effect at the junction is explained, and the various equations of the thermionic effect are co-ordinated On certain assumptions they lead to the conclusion that the Thomson P.D is the same for the same difference of temperature in all conductors.

Finally, in a paper on the seat of the electromotive force of the galvanic cell (*Phil Mag*, Nov.) Mr. Butler co-ordinates the results of his previous papers, and derives a statistical theory of the galvanic cell The existence of large metal contact P.D.'s is not inconsistent with the correspondence between the E.M.F. of the cell and the energy of the chemical reaction. The metal contact P.D. theory, the chemical theory, the Nernst theory of metal electrode potential differences and the relation between E.M.F. and total energy change expressed by the Gibbs-Helmholtz equation are included in the new theory as different aspects of the whole truth.

University and Educational Intelligence.

BIRMINGHAM.—The annual meeting of the Court of Governors was held on February 26. The report of the Principal (Mr. C, Grant Robertson), which was presented to the meeting, shows that during the last session the number of students diminished slightly as compared with the number for the preceding session. The total, however, is still 50 per cent higher than in the year before the War. An encouraging fact is the increase in the proportion both of full-time degree students and of post-graduate students

New buildings are to be erected at Edgbaston for the Petroleum Mining Department, and it is hoped that they will be ready for occupation by October next The transfer of this department will give room for the expansion of the Department of Coal Mining. An effort is being made to provide further buildings, which are urgently needed, for an extension of the Department of Chemistry and for the removal of the Biological Departments to Edgbaston, but the great increase in the cost of building is a very serious obstacle to be overcome

Two important events of the year have been the creation of a chair of law (of which Mr C F. Smalley-Baker is the first occupant) and the establishment of a readership in geography

CAMBRIDGE.—Dr J H Jeans has been appointed Rouse Ball lecturer in mathematics for the present academic year

LONDON.—Mr J. H Dible has been appointed to the University chair of pathology tenable at the London School of Medicine for Women Prof. Dible studied at the University of Glasgow In 1919 he was appointed lecturer in pathology in the University of Manchester and assistant pathologist to the Manchester Royal Infirmary, and in 1921 lecturer in bacteriology and senior assistant in the Department, carrying out work both for the Ministry of Health and for public bodies and hospitals in Manchester and adjacent towns

The title of reader in economics in the University has been conferred on Dr. Hugh Dalton, in respect of the part-time appointment which he will hold at the London School of Economics from August 1, on his resignation of the Sir Ernest Cassel readership in commerce. The title of emeritus professor of hygiene in the University has been conferred on Prof H, R Kenwood, who held the Chadwick chair of hygiene at University College from 1904 to 1924, and the title of emeritus professor of medicine at University College on Sir John Rose Bradford, who occupied at that College the chair of materia medica, pharmacology, and therapeutics from 1895 to 1903, and the chair of medicine and clinical medicine from 1899 to 1907.

The School of Pharmacy of the Pharmaceutical Society of Great Britain has been admitted as a School of the University in the Faculty of Medicine (in pharmacy only) for a period of five years as from January 1 last.

The following Doctorates have been awarded:—*D.Sc.* (*Biochemistry*): Mr. Robert Robison (Lister Institute of Preventive Medicine), for a thesis entitled "Hexosephosphoric Esters and their Physiological Functions"; *D.Sc.* (*Chemistry*): Mr. G. R. Clemo, for a thesis entitled "Strychnine and Brucine," and other papers; *D.Sc.* (*Physics*): Mr. Frederick Simeon, for a thesis entitled "1. The Carbon Arc Spectrum in the Extreme Ultra-Violet; 2. Note on the Striking Potential necessary to produce a Persistent Arc in Vacuum," and other papers; *Ph.D.* (*Science*)—Mr. L. Horton (Imperial College—Royal College of Science) for a thesis entitled "The Effect of the Alteration of the Carbon Tetrahedral Angle upon the Ease of Formation of Heterocyclic Rings", Mr A B Manning (Imperial College—Royal College of Science) for a thesis entitled "Researches on Gelatin", Mr E. G Richardson (East London College) for a thesis entitled "Aeolian Tones, Vibrations excited by Fluid Motion", Mr. J W Baker (Imperial College—Royal College of Science) for a thesis entitled "The Formation and Stability of Compounds containing Associated Alicyclic Rings (highly strained Rings)"; Mr I Cohen (Middlesex Hospital) for a thesis entitled "Observations on Variations in Blood and Urinary Diastase, with special reference to Meals and Starvation", Mr. E C. Dodds (Middlesex Hospital) for a thesis entitled "Observations on the Body Diastase," and other papers, Mr. W Russ (University College) for a thesis entitled "1 The Phosphate Deposits of Abeokuta Province 2 The Riebeckite Rocks of Northern Nigeria", Mr E R Trotman (University College, Nottingham) for a thesis entitled "The Preparation of Quaternary Hydrocarbons"

Prof E Barclay-Smith, professor of anatomy since 1915, and Prof O W. Richardson, appointed Wheatstone professor of physics in 1913 and relinquishing that appointment in 1924 on appointment as one of the Yarrow research professors of the Royal Society, have been appointed fellows of King's College

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A CONVERSAZIONE will be held at the Chelsea Polytechnic, Manresa Road, London, S W 3, on March 13 The laboratories and workshops will be open for inspection, 6.30-10 30 P M

APPLICATIONS are invited for a research studentship in tropical medicine in connexion with the government of the Federated Malay States The annual value of the studentship is 700*l* Particulars of the post, and forms of application, are obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S W 1.

APPLICATIONS are invited by the Glamorgan Agricultural Committee for the position of instructor in dairy and poultry husbandry Special knowledge of poultry keeping on the farm, and dairy farming (including clean milk production), and good technical qualifications are expected from candidates Application forms (returnable by March 16 at latest) can be obtained from the Director of Agriculture, 5 Pembroke Terrace, Cardiff

THE work of research has received a noteworthy and welcome stimulus at Armstrong College, Newcastle-on-Tyne An anonymous gift of 12,000*l* enabled the Council to establish a Research Endowment Fund in 1923, and the Committee which was appointed to administer the fund has published its first annual report. The Committee records its intention to utilise the proceeds to help members of the College and others with their researches by providing temporary or partial relief from teaching or by arranging for assistance, and by defraying the cost of books, apparatus, travelling and other expenses thus to supplement the resources already in operation and not to supersede the provision available for the training of post-graduates These considerations have guided the Committee in allocating grants during the first year. The Committee has also been able to arrange for a grant being given by the Newcastle and Gateshead Water Co. for a special research; and intimates a desire to advise or to co-operate with industrial firms and corporations desiring investigations in any particular direction. The opportunity has been taken to give a list of papers which have been published by members of the College staff during the year, and from this, although it is not exhaustive,

it is evident that all departments are actively engaged in research.

LORD EMMOTT presided at an important meeting held in the Regent Street Polytechnic, London, on Friday, February 27, when the question of an inquiry into the relationship of technical education to other forms of education and to industry and commerce was discussed. The case for the inquiry was presented by Lord Emmott and Mr J Wickham Murray (Joint Committee of the Three Technical and Art Associations) Their speeches indicated that, although technical education forms the contact-point between education and industry, its place in the national system of education is undefined Since, in any area, the technical institute draws its pupils from all other types of school, it is essential—if waste and overlapping are to be prevented—that its relationship to those other schools should be clearly understood Further, since technical education (including applied art) is the contact-point with industry, it is very necessary that more definite relationships be established if education is successfully to be linked to the world's work Educationists and industrialists seem more than ever to be sharply critical of each other's aims and methods, but no comprehensive attempt has been made towards sane and tolerant discussion of mutual problems It is now proposed to bring together not only primary, secondary, technical, and university teachers, but also employers, representative industrial and commercial bodies, and learned institutions Among the bodies represented at the meeting were the British Association, the Federation of British Industries, professional engineering bodies, teachers' associations, Institutes of Chemistry and Physics, and the British Science Guild The meeting finally resolved that the inquiry was desirable, and that the bodies represented be asked to appoint representatives to a committee whose work will be the preparation of the ground which the inquiry will cover

THE Parliamentary Grant (ordinary) for universities and university colleges in the British Isles, which was increased in 1921 from 1,000,000*l.* to 1,500,000*l.* (including 110,000*l* for Irish universities), did not escape the attention of the Geddes Economy Committee For each of the two succeeding years it was (for Great Britain only) 1,169,000*l*, and for 1924–25 it is 1,122,570*l.*, excluding the new grants (amounting now to 120,000*l*) for Oxford and Cambridge. Last November a deputation from all the universities of Great Britain, except Oxford and Cambridge, headed by Sir Donald MacAlister, waited upon the Chancellor of the Exchequer to urge the raising of the grant to 1,500,000*l*. A letter on this subject from Mr. Churchill to Lord Balfour, who introduced the deputation, was published in the *Times* of March 2. After reciting the salient points of the case presented by the deputation, which was very sympathetically received, the letter announces the stabilisation of the grant for five years at 1,380,000*l* (excluding provision for Oxford and Cambridge) For this relief the universities will, undoubtedly, echo the expression of thanks conveyed in Lord Balfour's reply, and if their gratification is tempered by regret that Mr. Churchill has so firmly required them to forgo the expectation of any further increase for at least five years, they cannot fail to recognise that even this condition carries with it compensations, among which may be reckoned the greater precision and therefore effectiveness with which they will be able to define their needs when appealing for aid to local authorities, to alumni, and to the public. The amount at which the grant has now been fixed (1,380,000*l.*) is approximately 39 per cent of the aggregate annual expenditure of the universities concerned in 1922–23.

Early Science at Oxford.

March 7, 1683/4.—After ye reading of ye Minutes, Dr. Plot was pleasd to acquaint ye Society that he had lately calcined clay-ochre, and stone-ochre (both which were yellow, from Shotover) about thirty-six hours, but neither of them applyed to ye Magnet; which gave ye Doctor grounds to question, whether yellow ochres will be affected by ye Magnet after any calcination, how long soever Tobacco-pipe clay, Marl, Bole armeniac and Terra Lemnia were calcined ye same space of time, but none of them applyed to ye Magnet

Then Dr Pit was pleased to inform ye Society that Oyl Olive is uncapable of any ebullition after it has spent its aqueous parts, which rise in bubbles, for, being pressed with a stronger fire, than what made water boyl over a large vessell, it could not be sensibly raised, although ye heat of ye oyl was so intense, that, being removed from ye fire, it broke out into a flame, and continued to do so after six or seven suffocations of ye flame Butter boyls over till its serous parts are evaporated, but afterwards, though pressed with a very great heat, is no more capable of ebullition, than so much melted lead

A Report of ye consultation, held for ye drawing up Articles, for ye better Regulation of ye Society, was offered, but ye examination of it was deferred, till ye next meeting which was ordered to be on ye Tuesday following, at 2 after dinner

March 8, 1686/7.—Dr Plot reported on the prices of commodities in the time of King John, which he had extracted from a Dugdale manuscript in the Ashmolean Library Mr President wrote to Mr. Halley several arguments against Mr Hooke's late hypothesis of the change of the surface of ye Earth.

March 9, 1685/6.—Dr. Lister of London communicated a paper of Georgics concerning ye improvement of Sandy land by ye *Vicia multiflora nemorensis perennis sive Dumetorum* I B which is practised both in Yorkshire and Staffordshire

March 10, 1684/5.—Mr Maunders speaking of ye dismall weather on ye 23rd of December last, says, that above eighty Persons were found killed by it, in Wiltshire and Dorsetshire. Some died suddenly, others by degrees: some, that escaped, were so tormented in their hands, and face (parts exposed to ye cold) that, as they recovered, and ye swellings abated, the skin peeled off, and they were some days without ye use of their limbes, and sometimes of their senses.—Part of Mr. King's ingenious discourse of Bogs was read; and also Mr Aston's letter relating that ye Savages of Canada get from Maple juice a sugar as sweet as that of ye Canes

March 11, 1683/4.—Salamander's wool was observed, by Mr Ballard, to be separated from ye earthy parts, to which it is joynd, by heating the Amianthus and bruising it into peices. It was ordered, that some attempts should be made, towards ye working this wool into a thread, that so we may [if it be possible] either trace out ye methods of ye Antients, or equall their inventions with new ones in this kind; for ye effecting of which, Dr. Beeston was pleased to take on him, ye trouble of employing some curious hand, suitable to so ingenious a design.

March 13, 1687/8.—Mr. Cole of Bristoll discoursed concerning the Descent of Spiders with their webs, taken in the County of Wilts in September and October 1686, with an occasionall discourse about Spontaneous Generation wherein is given allso an account of people that have been witnesses of the raining of frogs and crabs.

Societies and Academies.

LONDON.

Royal Society, February 26.—E. H. **Starling** and E. B. **Verney**: The secretion of urine, as studied on the isolated kidney The mechanism of urinary secretion in mammals has been studied by perfusing the dog's kidney with the heart-lung preparation The glomeruli filter from the blood plasma its non-protein constituents. Hydrocyanic acid suspends tubular activity, while the action of hydrocyanic acid is reversible. Urea, sulphate, and, when present in the serum, phenosulphonephthalein, are secreted by the tubule cells into the glomerular filtrate. Water, chloride, bicarbonate, and glucose are re-absorbed by the tubule cells from the glomerular filtrate. Water appears to be re-absorbed lower down the tubule than chloride Pituitrin causes a marked increase in the percentage and absolute amounts of chloride and a decrease in the amount of water eliminated Substances of this type normally regulate the output of water and chloride in the intact animal, and the characters of the urine secreted by the isolated organ are due in large part to their absence.—F. **Eicholtz** and E. H. **Starling** The action of inorganic salts on the secretion of the isolated kidney Calcium working on a background of potassium leads to an increase of chloride excretion and water output, due to decreased re-absorption in the tubules. These salts, if given separately, have no definite effects Inorganic phosphates decrease the output of water and chlorides by turning the calcium ion into a colloidal form. To this colloidal form the glomerulus membrane is impermeable Cyanide increases the permeability of the glomerulus membrane and allows the colloidal phosphates to appear in the urine.—G. V. **Anrep**. A new method of crossed circulation The method consists in an arterial anastomosis between a heart-lung preparation and the descending aorta or the brachio-cephalic artery of another animal Thus the part of the animal connected with the heart-lung preparation receives its blood supply from the latter, while the remaining part of the animal continues to be fed by its own heart The blood flow and the blood pressure of the perfused part of the animal is therefore under complete control.—G. V. **Anrep** and I. de B. **Daly**. The output of adrenaline in cerebral anæmia, as studied by means of crossed circulation. In this condition there is an increased liberation of adrenaline from the suprarenal glands, which is due to a true secretion and not to redistribution of blood, and the increased secretion disappears after denervation of the suprarenal glands.—G. V. **Anrep** and E. H. **Starling**: Central and reflex regulation of the circulation. Mechanical rise in blood pressure in the brain inhibits the vasomotor centre and stimulates the cardio-inhibitory, the two centres acting synergetically to produce lowered pressure Asphyxia by cerebral anæmia stimulates both vasomotor and cardio-inhibitory centres, the centres acting antagonistically, not synergetically. Andrenaline (small doses) introduced into head circulation causes slowing of heart and fall of pressure in lower half of animal. Measurement of pressure in Circle of Willis shows these effects are due to increased circulation through medullary centres, and cannot be ascribed to direct excitation of centres by adrenaline itself. The effects are analogous to, and produced in the same way as, those obtained on increasing pressure in head circulation.—K. **Furusawa**: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Part IX. Muscular activity and carbohydrate metabolism in the normal individual. Results obtained are: On normal diet, carbohydrate only is responsible for the process of contraction and recovery from it. As duration of exercise is prolonged respiratory quotient of excess metabolism falls slowly, indicating that some substance other than carbohydrate is being called upon. On fatty diet, short-lived muscular exercise is performed at expense only of carbohydrate, as on normal diet. In long-continued exercise, fat takes part more quickly than on normal diet. In exercise of short duration, in which no change in general metabolism of body as a whole might be expected, the human body acts as though it were an isolated muscle, in which carbohydrate is the only substance oxidised, as shown by Meyerhof. The primary fuel of contraction, therefore, in human muscle is carbohydrate, and fat or protein is presumably used to replenish carbohydrate store disappeared.—A. **Hunter** and J. A. **Dauphinee**. (1) Quantitative studies concerning the distribution of arginase in fishes and other animals. (2) An approximative colorimetric method for the determination of urea with an application to the detection and quantitative estimation of arginase.—J. J. R. **Macleod** and N. A. **McCormick**: The effect on the blood-sugar of fish of various conditions, including removal of the principal islets (isletectomy).

Royal Microscopical Society, January 21.—A. Chaston **Chapman** The yeasts a chapter in microscopical science (presidential address) Some new technique, such as the use of ultra-violet light, applied to the investigation of the cytology of the yeast cell, might, in the hands of expert cytologists, yield results equally valuable to industry and to general biology The views of Cramer and others as to the dependence of intra-cellular enzymic activity on surface tension was referred to, and reasons were given for supposing these surface tension effects to be operative in connexion with some industrial fermentation processes The yeast cell is, in fact, a chemical laboratory of the highest efficiency, and of the most remarkable character, and if the processes of building up and breaking down, which are so quietly and so regularly occurring in a single cell of yeast, could be understood and artificially imitated, we should be not only within measurable distance of a new organic chemistry, but also appreciably nearer to an understanding of that greatest of all problems, the nature of life

Linnean Society, January 22.—Miss M. S. **Johnston**: Calcareous deposits (rhizocretions, Kindle) round roots of Canadian birches in Pleistocene sands. The concretion is considered to be due to the action of humic acid from the roots segregating the lime constituents in the sand.—R. D'O. **Good**. The flora of Canada. As in Britain, the largest plant families are the Compositæ, Gramineæ, Cyperaceæ, Leguminosæ, Rosaceæ, and Labiatæ, and the first named is very much larger than any of the others In traversing the country from east to west, four main vegetational types are encountered: the Eastern forest, the prairie, the mountain, and the Pacific littoral The southern limit of the Pleistocene ice was well down in the United States, and the present flora of Canada is therefore an immigrant flora developed in the geologically short time since the retreat of the ice.—J. **Munro**: Canadian forests and forestry. There are four climatic belts between the east coast and British Columbia.

CAMBRIDGE.

Philosophical Society, January 19.—H. F. **Baker**: A transformation of Segre's figure in space of four dimensions; the equation of Kummer's surface. There is a figure, first studied by Stéphanos in the

theory of circles, but studied particularly by Segre as a figure in four dimensions; consisting of fifteen lines meeting by threes in fifteen points. The figure is of great interest, as being the centre of a discussion of many well-known surfaces; the cubic surface, the cyclide, Kummer's surface, and so on. In this figure there are also six sets of fives of the lines, each being taken twice over, called sets of *associated* lines. The present paper finds a transformation from the lines of the figure to the joins of six points in space of *five* dimensions—a set of associated lines becoming the joins of one of the six points to the other five. Intimately related therewith is the expression of the equation of a Kummer surface by a sum of five squares. The coefficients of these squares are invariants of the discriminantal equation of the primary quadratic complex.—R. **Vaidyanathaswamy**: On simplexes doubly incident with a quadric. The generalisation of the figure representing a double six of lines in five dimensions, wherein a hexad is both inscribed to and circumscribed about a quadric.—H. G. **Green**: The classification of conicoids by their generators. An actual method of reduction of the equation of a conicoid to a form showing the character of the surface.—R. **Whiddington**: On the positive flash in vacuum discharge tubes. Moving striations previously observed in the rare gases were reinvestigated in the case of pure argon. The bright flashes travelling from the anode with velocities depending on the pressure show no Doppler effect. The luminous radiation seems to be excited by invisible radiation given out by positive ions as they travel along the tube.—E. C. **Stoner**: The structure of radiation. On the assumption of conservation of energy and linear momentum, the evidence in favour of radiation being constructed of linearly directed, spatially localised quanta is held to be conclusive. Further properties, which are not physically unreasonable, must be postulated of these quanta in order that interference phenomena may be possible.—Major P. A. **MacMahon**: The symmetric functions of which the general determinant is a particular case.

MANCHESTER.

Literary and Philosophical Society, January 20.—W. **Robinson**. On proliferation and doubling in the flowers of *Cardamine pratensis* L. Specimens of *C. pratensis* showing two main types of abnormality were found in meadows near Cheadle Hulme, Cheshire, in June 1923, one of which was similar to the double-flowered form, arising by proliferation of the ovary, described most frequently by previous observers, and the other, a less completely double-flowered specimen. Microscopic investigation showed that, in both types, proliferation took place by the meristematic activity of a growing-point at the base of the ovary, of a flower which was otherwise normal. In one case, however, the ovary itself was carried up on a stalk produced by the growth activity of tissues immediately below the base of the ovary, but outside this; in the other specimen all the growth took place within the ovary from the base of this, and the meristematic growing-point was carried up to about the middle of the pod-like structure. The doubling seen in *C. pratensis* has recently been spoken of as a mutation from the more normal single form, but Goebel has stated that by cultivating plants of the double form in sandy soil they completely lost the character. By vegetative multiplication from the original specimens collected wild at Cheadle Hulme, it has been possible to cultivate plants showing variations, both in the character and degree of the doubling. Further work will show whether the plasticity of *C. pratensis* is such that doubling can be produced under experimental conditions in a single-flowered form by nutritional changes as Goebel has suggested, or whether, as seems more likely, the double-flowered and single-flowered forms are two different races with distinct hereditary complexes.

PARIS.

Academy of Sciences, January 26.—G. **Bigourdan**: The propagation of Hertzian waves to great distances. The order of magnitude of the perturbations of this propagation. A table is given showing the results of the reception of the Bordeaux time signals for 1923, by Helwân (near Cairo), Washington, Ottawa, Greenwich, Paris and Uccle.—H. **Vincent**: The urinary elimination of the *Bacillus coli communis* and its hæmatogen origin.—P. **Bazy**: Remarks on the preceding communication.—Maurice **Lugeon**: The presence of fossilised organic bodies in the marbles of Uruguay. Fragments of echinoderms and molluscs have been recognised in marble from Nueva Carrara; this is of interest, as being the first occasion of the discovery of fossil remains in this crystalline deposit.—Bertrand **Gambier**: The continuous deformation of surfaces, isometry and applicability.—Mlle Thérèse **Leroy**: A new method for the determination of the working costs and a tariff for railway transport. A new tariff scheme has been developed as the result of a mathematical study of data from eighty years' actual railway experience.—**Andrieau**: The Andrieau motor. A detailed description of the mode of working, construction, and experimental results of a new design of internal combustion motor.—Carl A. **Garabedian**: Solution of the problem of the heavy rectangular plate, framed or open, carrying a charge uniformly distributed or concentrated at its centre.—A. **Alayrac**: The theoretical study of motorless flight in a variable horizontal wind.—Ernest **Esclangon**: The eclipse of the sun of January 24, 1925, observed at the Strasbourg Observatory. The time of first contact, deduced from two series of independent measurements of the chord of contacts, was $15^h\ 3^m\ 37^s$.—L. **d'Azambuja**: Observation of remarkable protuberances, made at the Meudon Observatory, January 24, 1925, before the eclipse of the sun. On January 24 a series of spectroheliograms of the lines K_3 (calcium) and H_3 (hydrogen) was taken continuously. A photograph taken at 11.10 A.M. with the calcium line showed the existence in the N.W. quadrant, of a fan-shaped group of protuberances in the form of jets, the largest of which attained a height of one-fifth of the solar radius. Its development was very rapid, since photographs at 10.40 A.M. and 12.20 P.M. did not show it.—J. **Guillaume** and Mlle. M. **Bloch**: Observation of the partial eclipse of the sun of January 24, 1925, made at the Lyons Observatory. Clouds interfered with observations. First contact was noted at $15^h\ 4^m\ 36^s{\cdot}2$.—P. **Chofardet**: Observation of the eclipse of the sun of January 24, 1925, at the Besançon Observatory. Time of first contact at $15^h\ 3^m\ 48^s{\cdot}8$.—F. **Holweck**: Determination of the critical potential L_{III} of argon. Discussion of the precision of this measurement and of analogous measurements.—Ed. **Friedel**: Smectic bodies and X-rays. The existence of a stage (smectic state) intermediate between the solid crystal and the true liquid has been indicated in an earlier communication for certain oleates. These conclusions have been questioned, and additional experiments on the radiograms furnished by ethyl *p*-azoxy-benzoate, and ethyl azoxy-cinnamate have been made. The results confirm the conclusions previously given.—F. **Baldet**: The spectrum of carbon monoxide at very low pressure; the so-called comet-tail spectrum.—Ernest **Bengtsson** and Erik **Svensson**: The conditions

of the appearance and structure of the silver bands, λ3330 and λ3358.—F. Croze: The structure of the line spectra of ionised nitrogen and oxygen.—Jean Jacques Trillat: The molecular orientation of the fatty acids.—Herbert Brennen: Chemical studies on the isotopes of lead. A partial separation of the isotopes of lead by the action of the Grignard reagent on lead chloride has been recently described by Dillon, Clarke, and Hinchy. This work has been repeated, and no evidence of separation of isotopes was obtained.—Georges Fournier: The absorption of the β-rays by matter. If μ is the coefficient of absorption and ρ the density of the material, then experiments with six materials show that the relation $\mu/\rho = a + bN$ (where N is the atomic number) is valid.—A. Bigot: Clays, kaolins, etc.—L. Blanc and G. Chaudron: The magnetic study of the stable form of the sesquioxides of iron and chromium. The magnetic susceptibility of Fe_2O_3 and Cr_2O_3 as a function of the temperature is given in graphical form. the results are difficult to interpret.—André Graire: The reduction of the oxides of nitrogen in the presence of sulphuric and sulphurous acids.—Marcel Godchot and Pierre Bedos. The chlorination of para-methyl-cyclohexanone.—Ch. Courtot and P. Petitcolas: Syntheses of 9-fluorenylamines.—J. Barthoux: Description of a new mineral, dussertite. This mineral, found at Djebel Debar, is an arsenate of the composition $(FeAl)_3(CaMg)_3(OH)_9(AsO_4)_3$. The full chemical analysis, physical and mineralogical description are given.—Pierre Bonnet: The problem of the Trias of the Avallonnais and Auxois.—Pierre Dangeard: Limits of the submerged plant growth of Lake Annecy at varying depths.—P. Mazé: The plurality of the products of photosynthesis, deduced from the study of the gaseous exchanges between the atmosphere and the whole plant.—Mlle. Sara Bache-Wüg: The vacuome of *Erysiphe graminis*.—P. E. Pinoy: Concerning the cancer of plants or crown gall. L. Ravaz and G. Verge: A disease of the vine, excoriosis.—Mme. Jean Francois-Perey: The influence of the culture medium on protozoa counts in soil. The influence of the culture medium is marked; an extract of the earth with gelose is recommended as giving the most trustworthy results.—C. F. Muttelet: Study of the development of the pea; from the point of view of conservation for food.—Vittorio Pettinari: The toxic action of *Amanita phalloides*.—Georges Bourguignon and J. B. S. Haldane: The evolution of chronaxy in the course of the crisis of experimental tetany by voluntary hyperpnea in man.—A. Malaquin: The segregation, in the course of ontogenesis, of two primordial sexual cells; origin of the germinal descent in *Salmacina Dysteri*.—Robert Weill: Foci of formation and ways of migration of the nematocysts of *Halyclistus octoradiatus*. The existence, along their path, of selective reservoirs.—J. Chaine: Remarks on the penian bone.—Armand Dehorne: The petaloid expansions of the leucocytes of the Chetopoda. The case of *Leydenia Gemmipara*.—Ph. Joyet-Lavergne: The lipoids and fats of the Sporozoa.—Edouard Chatton and André Lwoff: The physiological determinism of the phases of the cycle of the infusorian *Spirophrya subparasitica*.—A. Berthelot and G. Ramon: The agents of transformation of the toxins into anatoxins. Toxins can be converted in various ways into substances deprived of toxic power, but retaining the power of flocculation (*in vitro*) and immunising power (*in vivo*). These products are described as anatoxins, and the action of a large number of chemical compounds on the diphtheria toxin has been studied from this point of view. The most effective reagents for the production of the diphtheria anatoxine proved to be acrolein, crotonaldehyde, acetaldehyde and hexamethylenetetramine.

Official Publications Received.

Department of the Interior: United States Geological Survey. Bulletin 751-E: The Scobey Lignite Field Valley, Daniels, and Sheridan Counties, Montana. By Arthur J. Collier. Pp. v + 157-280 + plates 24-39. (Washington: Government Printing Office.)

Department of the Interior. United States Geological Survey. Professional Paper 132-F. Relations of the Wasatch and Green River Formations in North-Western Colorado and Southern Wyoming, with Notes on Oil Shale in the Green River Formation. By J. D. Sears and W. H. Bradley. Pp. ii+93-107+2 plates. *Professional Paper* 132-G: Discovery of a Balkan Fresh-water Fauna in the Idaho Formation of Snake River Valley, Idaho. By W. H. Dall. Pp. ii+109-115+1 plate. Professional Paper 132-H. The Resuscitation of the Term Bryn Mawr Gravel. By F. Bascom. Pp. 117-119. (Washington: Government Printing Office.)

"The First Five Thousand" being the First Report of the First Birth Control Clinic in the British Empire, "The Mothers' Clinic" for Constructive Birth Control at 61 Marlborough Road, Holloway, London, N. 19. By Dr. Marie Carmichael Stopes. Pp. 67. (London: J. Bale, Sons and Danielsson, Ltd.) 2s. 6d. net.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 260: Precise Triangulation, Traverse and Leveling in North Carolina. By Walter D. Sutcliffe and Henry G. Avers. (Special Publication No. 101.) Pp. iv+184. (Washington: Government Printing Office.) 25 cents.

Annuaire de l'Observatoire Royal de Belgique. Par P. Stroobant. 93me année, 1926. Pp. iii+154. (Bruxelles.)

The Physical Society of London. Proceedings, Vol. 37, Part 2. February 15. Pp. 75-100+50 D. (London: Fleetway Press, Ltd.) 6s. net.

Thirty-eighth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1916-17, with accompanying Paper, An Introductory Study of the Arts, Crafts and Customs of the Guiana Indians, by Walter Edmund Roth. Pp. vii+745+183 plates. (Washington: Government Printing Office.) 8 dollars.

State of Illinois Department of Registration and Education Division of the Natural History Survey. Bulletin, Vol. 15, Art. 3. Second Report on a Forest Survey of Illinois, The Economics of Forestry in the State. By Herman H. Chapman and Robert B. Miller. Pp. vii+46-172. (Urbana, Ill.)

Iowa Geological Survey. Vol. 29: Annual Reports, 1919 and 1920, with Accompanying Papers. Pp. xlviii+568+54 plates. (Des Moines.)

University of Iowa Studies in Natural History. Vol. 10, No. 5. Fiji-New Zealand Expedition. Narrative and Preliminary Report of a Scientific Expedition from the University of Iowa to the South Seas. By C. C. Nutting; with Chapters on Ornithology and Entomology by Dayton Stoner, on Botany by R. B. Wylie, and on Geology by A. O. Thomas. Pp. 269+58 plates. (Iowa City.) 8 dollars.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1924. Pp. iv+400+50. (London: H.M. Stationery Office.) 10s. 6d. net.

Ministry of Agriculture, Egypt. Technical and Scientific Service. Bulletin No. 50. A Third Bioclimatic Study in the Egyptian Desert. By C. B. Williams. Pp. ii+32+7 plates. (Cairo: Government Publications Office.) 5 P.T.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 6. Studies in the Chemistry of Sugarcane. 2. Some Factors that determine the Ripeness of Sugarcane. By D. Viswanath and S. Kasinatha Ayyar. Pp. 123-144. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 8 annas; 9d.

Western Australia. Annual Progress Report of the Geological Survey for the Year 1923. Pp. 38+8 plates. (Perth: Fred Wm. Simpson.)

Department of the Interior: Bureau of Education: Bulletin, 1924, No. 19: Schools for Adults in Prisons, 1923. By A. C. Hill. Pp. iii+33. (Washington: Government Printing Office.) 5 cents.

Diary of Societies.

SATURDAY, MARCH 7.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (at Institution of Mechanical Engineers), at 11 A.M.—Lord Emmott and Ppl. W. M. Varley: The Local College and its Relation to Surrounding Education Authorities.—G. Mavor: Training and Education for Apprenticeship.—J. E. Montgomery: The Working of the Schemes for National Certificates and Diplomas in Engineering.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern and South Midland Districts) (at Town Hall, Ealing), at 2.35.—The Question of Regional Town Planning.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (II.).

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—Dr. F. W. Crossley-Holland: Science and the Criminal.

MONDAY, MARCH 9.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—A. H. R. Goldie: Discontinuities in the Atmosphere.—Dr. A. P. Laurie: Stone Decay and the Preservation of Buildings (Address).—W. H. Watson: An Investigation of the Absorption of Superposed X-Radiations.—H. W. Turnbull and J. Williamson: The Minimum System of Two Quadratic Forms.—Prof. H. S. Allen: Note on Whittaker's Quantum Mechanism.—Marion C. Gray: The Equation of Conduction of Heat.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. C. Gardner: Nature and Supernature.

BIOCHEMICAL SOCIETY (at Lister Institute), at 5.—F. W. Fox: The Cholesterol Content of Bile and its Bearing upon the Metabolism of Cholesterol and the Bile Acids.—J. R. Marrack: The Total Base Content of Plasma.—D. Hoffert and I. S. MacLean: The Action of Yeast on Lactic Acid.—E. H. Lepper and C. J. Martin: (a) The Influence

of Salt Concentrations on the C_H of Buffer Solutions as indicated by the Electrometric and Colorimetric Methods respectively: (*b*) Can the C_H of Mixtures of $NaHCO_3$ and CO_2 in High Dilutions be determined by the Hydrogen Electrode?

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Presentation, by Sir St. Clair Thomson, of the North Persian Forces Memorial Medal for 1923 to Wing-Commdr. H. E. Whittingham, for his Paper, Observations on the Life-History and Bionomics of *Phlebotomus papatasii*, written in conjunction with Flight-Lieut. A. F. Rook.—Wing-Commdr. H. E. Whittingham: The Treatment of Malaria by Novarsenobillon.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—Major E. I. David: Electricity in Mines.

INSTITUTE OF CHEMISTRY (Birmingham Section) (at White Horse Hotel, Birmingham), at 7.30.—G. W. Marlow: Chemists' Agreements.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. G. Lobley: Electric Furnaces.

SOCIETY OF CHEMICAL INDUSTRY (London Section) and INSTITUTE OF CHEMISTRY (London and South-Eastern Counties Section) (at Institution of Mechanical Engineers), at 8.—Sir Max Muspratt, Bart.: Chemistry and Civilisation.

SURVEYORS' INSTITUTION, at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—A. F. R. Wollaston: The Sierra Nevada of Santa Marta, Colombia.

MEDICAL SOCIETY OF LONDON, at 8.30.—E. Clarke, A. F. Moore, Dr. J. Collier, and others: Discussion on The Fundus Oculi in General Medicine.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—Dr. F. W. Crossley-Holland: Science and the Criminal.

TUESDAY, MARCH 10.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. MacNalty: Epidemic Diseases of the Central Nervous System (Milroy Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. E. N. da C. Andrade: The Evolution of the Scientific Instrument (I.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (Annual General Meeting) (at Royal Society of Arts), at 5.30.—H. Barringer: Address.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Prof. S. M. Dixon and F. W. Macaulay: Measurements of Discharge over a Rock-faced Dam.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (*Informal Meeting*), at 7.—C. W. Sully and others: Discussion on Illumination.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Bradford Technical College), at 7.—H. W. Taylor: Three-wire Direct-current Distribution Networks: Some Comparisons in Cost and Operation.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Section) (at North British Station Hotel, Edinburgh), at 7.—E. Hughes: Iron Losses in D.C. Machines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Annual General Meeting.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—G. A. Whiteman and A. Spittle: The Manufacture of Brass Condenser Tubes, with some Notes on an Alternative Alloy.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry).

WEDNESDAY, MARCH 11.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—H. T. Angus and P. F. Summers: The Effect of Grain-size upon Hardness and Annealing Temperature.—S. L. Archbutt: A Method of Improving the Properties of Aluminium Alloy Castings.—U. R. Evans: Surface Abrasion as a Potential Cause of Localised Corrosion.—Dr. J. Newton Friend and J. S. Tidmus: The Influence of Emulsoids upon the Rate of Dissolution of Zinc in Solutions of Lead, Nickel, and Copper Salts.—At 2.—T. G. Bamford: Comparative Tests on some Varieties of Commercial Copper Rod.—R. Genders and G. L. Bailey: The Alpha Phase Boundary in the Copper Zinc System.—Dr. D. Bunting: The Influence of Lead and Tin on the Brittle Ranges of *Brass*.—E. A. Bolton: The Removal of Red Stains from Brass.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. O. T. Jones: The Geology of the Llandovery District (Carmarthenshire).—G. Andrew: The Llandovery and Associated Rocks of Garth (Breconshire).—G. Andrew and Prof. O. T. Jones: The Relations between the Llandovery Rocks of Llandovery and those of Garth.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 7.—J. S. Wilson: The Relative Importance and Nature of Secondary Stresses in Steel Structures.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Major E. I. David: Electricity in Mines.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—G. R. Hutchinson: Some Problems of the Motor Ship.

ROYAL SOCIETY OF ARTS, at 8.—E. Cammaerts: The Restoration of Public Buildings in Belgium.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Mechanical Engineers), at 8.—Prof. A. L. Mellanby: Expansion and Compression Phenomena in Steam Jets.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at Leeds).

THURSDAY, MARCH 12.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—G. L. Bailey and R. Genders: The Density and Constitution of the Industrial Brasses.—A. L. Norbury: The Effects of certain Elements on the Electrical Resistivity of Copper.—Sir Thomas Kirke Rose: The Density of Rhodium.—Prof. T. Honda and Prof. R. Yamada: Some Experiments on the Abrasion of Metals.—Prof. T. Ishara: The Equilibrium Diagram of the Aluminium-Zinc System.

ROYAL SOCIETY, at 4.30.—Sir Charles Sherrington: Remarks on some Aspects of Reflex Inhibition.—E. G. T. Liddell and Sir Charles Sherrington: Recruitment and some other Features of Reflex Inhibition.—D. T. Harris: Studies on the Biological Action of Light.—Dr. H. Hartridge and F. J. W. Roughton: The Kinetics of Hæmoglobin. III.—*To be read in title only*:—S. B. Schryver, H. W. Buston, and D. H. Mukherjee: The Isolation of a Product of Hydrolysis of the Proteins hitherto undescribed.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. MacNalty: Epidemic Diseases of the Central Nervous System (Milroy Lectures) (III.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. L. Hill: The *Biological Action of Light* (I.).

ROYAL SOCIETY OF MEDICINE (Comparative Medicine, Tropical Diseases, and Obstetrics Sections), at 5.30.—Special Discussion: Infective Abortion in Cattle and its Relation to Mediterranean Fever.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—H. W. Taylor: Three-wire Direct current Distribution Networks: Some Comparisons in Cost and Operation.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre (Dublin)) (at Trinity College, Dublin), at 7.45.—Dr. J. F. Crowley: The Use of Electricity in the Chemical Industries, with particular reference to the Irish Free State.

INSTITUTE OF CHEMISTRY (Liverpool and North-Western Section) (at Liverpool University), at 8.—Prof. E. C. C. Baly: A Lecture Tour in America.

FRIDAY, MARCH 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—G. Prasad: The Progression of Stellar Velocity with Absolute Magnitude.—Dr. J. W. Nicholson: The Secondary Spectrum of Hydrogen.—Dr. H. Jeffreys: The Origin of the Solar System, in relation to Prof. Eddington's Theory of Stellar Luminosity.—E. A. Kreiken: The Density Function in the Milky Way.—Dr. J. K. Fotheringham: Visibility of Stars in Great Britain during the Solar Eclipse of 1925, Jan. 24.—T. Royds: Note on Spectroheliograms taken with Different Parts of the H_α line.—S. D. Tacherny: (*a*) Results of Micrometer Measures of the Position of Mars relative to the Star B.D. −4° 5913 on 1924, Dec. 5; (*b*) Occultations of Stars by the Moon, 1924.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. P. Andrews: The Variation of Young's Modulus at High Temperatures.—Dr. E. G. Richardson: The Critical Velocity of Flow past Objects of Aerofoil Section.—Dr. J. Brebtano: A Focussing Method of Crystal Powder Analysis by X rays.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Reports to the Cutting Tools Research Committee.—Prof. E. G. Coker: The Action of Cutting Tools.—D. Smith and A. Leigh: Experiments with Lathe Tools on Fine Cuts, and some Physical Properties of the Tool Steels and Metal operated upon.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Judge: Many Slides and a few Remarks.

INSTITUTE OF METALS (Swansea Local Section) (at Swansea University College), at 7.15.—General Discussion.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. P. Rale: Notes on *Methods of Producing Modern High Grade Machine Tools*.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Gilbert Murray: The Beginnings of the Science of Language.

SATURDAY, MARCH 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (III.).

PUBLIC LECTURES.

SATURDAY, MARCH 7.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Modern Excavations in Egypt.

MONDAY, MARCH 9.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. L. Lévy-Bruhl: Trois Philosophes français contemporains: Ribot, Espinas, Durkheim (in French) (Succeeding Lectures on March 10, 13.)

UNIVERSITY COLLEGE, at 5.30.—Prof. H. Westergaard: Vital Statistics. (Succeeding Lecture on March 11.)—Miss E. Jeffries Davis: Some Famous London Bridges (I.) (Succeeding Lectures, by Prof. A. E. Richardson, on March 16, 23.)

INNER TEMPLE HALL, at 3.—*Lord Newton*: The Necessity for Legislation with regard to Smoke Abatement (Chadwick Lecture).

TUESDAY, MARCH 10.

UNIVERSITY COLLEGE, at 5.30.—R. A. Smith: The Old Stone Age.

UNIVERSITY OF LEEDS, at 8.—E. Percival: The Freshwater Zoology of Yorkshire (I.).

WEDNESDAY, MARCH 11.

SCHOOL OF ORIENTAL STUDIES, at 5.15.—E. Richmond: Early Moslem Architecture. The Early Madrassas in Syria, Bagdad, Egypt up to end of Ayyubi Dynasty. Developments during the Mamluke Period up to the Turkish Conquest.

KING'S COLLEGE, at 5.30.—Prof. E. Prestage: Travel and Travellers of the Middle Ages (IX.). The Opening of the Ocean Routes, A.D. 1415–60.

UNIVERSITY COLLEGE, at 5.30.—Miss Ethel S. Fegan: Library Resources outside London.

THURSDAY, MARCH 12.

UNIVERSITY COLLEGE, at 5.—Prof. E. A. Gardner: History of Ancient Sculpture (Introductory Lecture).

SATURDAY, MARCH 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. R. L. Sherlock: Man as a Geological Agent.

Supplement to NATURE

No. 2888 MARCH 7, 1925

Electric Forces and Quanta.[1]

By J. H. JEANS, Sec. R.S.

IT is just about twenty-five years since Lord Kelvin spoke of "two clouds" obscuring "the beauty and clearness of the dynamical theory which asserts light and heat to be two modes of motion." The clouds which Lord Kelvin saw as clouds no bigger than a man's hand have grown until they have almost filled the firmament: little can now be seen of the beauty and clearness of the dynamical theory of which Lord Kelvin spoke. The old dynamical theory has given place to the new theories of relativity and of quanta; what Lord Kelvin thought were transient clouds shortly to melt away have proved to be new theories in process of growth, the "beauty and clearness" he saw under these clouds was mostly a mirage.

I have chosen as my title "Electric Forces and Quanta," the two halves of this title corresponding roughly to the two new theories, and I propose to try to sketch out the changes these theories have introduced into our conception of fundamental electrical processes. Let us consider electric forces first. Lord Kelvin, following Maxwell and Faraday, regarded an electric force as evidence of a stress in the ether. An ether can transmit two kinds of stress, one arising from a state of static strain and the other from a transfer of momentum; these were supposed to be electric and magnetic forces respectively. Or, to put the matter in another way, an ether can possess two kinds of energy, potential and kinetic; these were identified with electrostatic and electromagnetic energy respectively. This mechanism of stresses in the ether was devised in order to escape the necessity of "action at a distance." The ether itself had no doubt originally been brought into existence for quite other reasons—to provide a nominative to the verb "to undulate," according to the late Lord Salisbury—but these other reasons were no longer of much cogency. Light, whether an undulation of a medium or not, was admittedly an electromagnetic phenomenon, and the electromagnetic theory of light had already made it clear that any mechanism which could account satisfactorily for electric and magnetic forces could carry the whole of the undulatory theory as well. It was because Maxwell and Faraday had disliked "action at a distance" that the ether continued in existence at the end of the nineteenth century.

A Medium or Action at a Distance

Nevertheless, the conception involved a difficulty which seems to have troubled the nineteenth-century physicists not a little. The energy of the ether could represent all kinds of electromagnetic energy, but could represent nothing else. Gravitational energy, for example, could not be interpreted as ethereal energy, for the only two types of energy which the ether could hold were already allotted to electric and magnetic energy respectively. It is true that attempts were made to interpret gravitation as normal waves of compression or as pulsations of very high frequency in the luminiferous ether, but such explanations never survived comparison with facts, and those who tried to explain gravitation had to fall back either on a new and entirely separate ether or else on action at a distance. If action at a distance had to be called in to explain gravitation, it might just as well be allowed to explain electromagnetism as well, there seemed to be no logical resting-place between two ethers and none. But the need for multiple ethers simultaneously filling space aroused suspicions in those who were conversant with the history of science. In an earlier century, according to Sir Joseph Larmor, "aethers were invented for the planets to swim in, to constitute electric atmospheres and magnetic effluvia, to convey sensations from one part of our bodies to another, and so on, till all space had been filled three or four times over with aethers. It is only when we remember the extensive and mischievous influence on science which hypotheses about aethers used formerly to exercise, that we can appreciate the horror of aethers which sober-minded men had during the eighteenth century."

In time it became clear that the only thoroughly satisfactory possibility was no ether at all. First the development of the theory of relativity gave its death-blow to the old luminiferous ether of Lord Kelvin, Maxwell, and Faraday. The main result of this theory can be stated in the form that all the phenomena of Nature go on precisely as though there were no ether.

[1] The Sixteenth Kelvin Lecture, delivered on February 5 at the Institution of Electrical Engineers.

This does not of course abolish the ether; it shows the conception of an ether to be superfluous and perhaps even a little bit ridiculous—for it is ridiculous to fill the whole of space with a medium and then agree that everything goes on just as if the medium were not there—but it does not show it to be illogical.

The Existence of an Ether.

To the question, "Does an ether exist?" science is still unable to give a definite answer. The question, "Does the ether exist?" if the ether is taken to mean the luminiferous ether of Maxwell and Faraday, ought almost certainly to be answered in the negative. Speaking for a moment in the language of technical mathematics, the reason is that all the phenomena of Nature are invariant to the Lorentzian transformation (the transformation to axes moving with a uniform velocity), whereas the physical properties allotted to the ether by Maxwell and Faraday are not invariant. Let E and H denote the electric and magnetic force at a point in the supposed ether, then E^2-H^2 (the integrand in the action integral) is invariant, so that all properties which follow from the principle of least action are independent of the motion of the observer. These are of course the dynamical properties of the system. But E^2+H^2 is not invariant, so that the phenomena which follow from attributing energy to the ether at a rate $(1/8\pi)(E^2+H^2)$ per unit volume are not the same for a moving observer as for a stationary one.

Of the six components of stress attributed by Maxwell to the ether, only three are invariant, so that electromagnetic phenomena, if explained in terms of ether stresses, call for stresses which are not the same for a moving observer as for one at rest even though the observed phenomena are absolutely identical. For example, if magnetic forces are of ethereal origin, then the forces observed by a moving observer must be of quite different nature and origin physically from those observed by an observer at rest. If the latter observer's forces are produced by Maxwell's mechanism, the former's cannot be. To take the simplest example: an observer moving through a stationary electrostatic field will in actual fact observe magnetic forces just as much as if the field moved past him, yet the ether at every point of his path possesses no kinetic energy and so, according to the Maxwell-Faraday conception, could show no magnetic forces. The old Maxwell-Faraday ether had in some way to provide a duplicate mechanism for a single phenomenon, the magnetic force arising from an electric charge—and similarly for most other phenomena. No one has ever shown that it is capable of doing this; but even if they had, the duplication of mechanism to produce a single phenomenon is so contrary to the usual workings of Nature that there is not much risk in dismissing the old ether to the lumber-room.

Thus we may be confident that if an ether exists, it must be something very different from the Maxwell-Faraday ether. It must probably be thought of as a four-dimensional structure and must be more subjective than the Maxwell-Faraday ether. Each of us must carry his own ether about with him, extending through all space and all time, much as in a shower of rain each observer carries his own rainbow about with him. Whether such a structure, if it exists, ought to be called an ether, others must decide.

We may remark in passing that the conception of an ether has always made a special appeal to the practical, one might almost say engineering, type of mind which we associate with the leaders of British science. While our own physicists have asked for Nature to be reduced to a machine transmitting tensions and stresses, the more metaphysical minds of the Continent have usually been content to accept action at a distance as an ultimate explanation of natural phenomena, or at least to regard such an explanation as being in every way as final and as satisfying as an explanation in terms of a medium. It was something more than a coincidence that Newton, Kelvin, Clerk Maxwell, and Faraday were all British, while Boscovitch, Einstein, and Weyl are not.

Four-dimensional Geometry.

The paper which practically abolished the ether as a serious scientific hypothesis was published by Einstein in 1905. Ten years later he published a second paper which may be said to have shown us how to get on without either an ether or action at a distance. His first paper, as afterwards interpreted by Minkowski, had shown that all the phenomena of electromagnetism might be thought of as occurring in a continuum of four dimensions—three dimensions of space and one of time—*in which it is impossible to separate the space from the time in any absolute manner*. You may separate them in one way, but you will find that I separate them differently, and in the end we shall both agree that no objective separation is possible.

Einstein's second paper showed that the phenomena of gravitation could be explained on the supposition that the geometry of this four-dimensional continuum was not of the ordinary Euclidean type. The continuum was supposed to be affected by kinks and twists in the neighbourhood of gravitating masses, and it was these, and not a "gravitational force," that threw a particle out of a straight course. It became just as inaccurate to say that the sun attracts the earth as to say that a bowl on an uneven bowling green is attracted or repelled by the other bowls. In this curved space

the path of a particle is always a geodesic—the most direct distance between two points—and this may have very different properties from a Euclidean straight line

We must, of course, remember that the paths we are discussing are in a four-dimensional space—if we were speaking of ordinary paths in three-dimensional space, it would clearly be ridiculous to say that the curved orbit of a planet provided the most direct path from perihelion to aphelion ; it is only when we allow for the motion in time as well as in space that the statement becomes reasonable We can get rid of most of the motion in time by supposing our planet, or other body, to move with enormously high velocity, and then the path described actually approximates to a straight line, which is now the most direct path even in three-dimensional space.

We can gain some conception of the main features of Einstein's geometry from the analogy of spherical geometry ; the curved surface of our earth provides a fair two-dimensional analogy to Einstein's curved four-dimensional space. To one who thinks in terms of "parallels" of latitude and longitude, or who studies geography on a Mercator chart, the most direct course on our earth's surface looks oddly curved : it is always a surprise to the unsophisticated traveller that the ship taking him from Southampton to New York (say from A to B in Fig. 1) turns a bit to the north on rounding the Lizard, while the great circle course on the ship's chart (AECB in Fig. 1) looks very much as if the ship were describing an orbit about a centre of attraction in the middle of the Sahara.

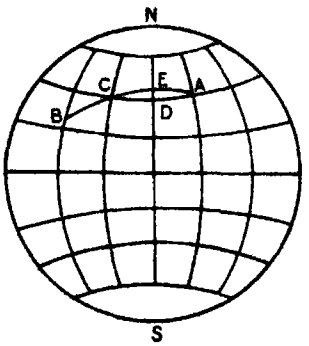


Fig. 1.

If Einstein was able to avoid the evils both of action at a distance and of an ether in the gravitational problem, there would seem to be no reason why they should not be similarly avoided in the electromagnetic problem which specially interests us to-night. Not only is there no reason why this should not be done ; it actually has been done. In 1918 Weyl pointed out that the geometry of Einstein was not the most general geometry which conformed to the relativity condition. Space could be distorted still further in ways unimagined by Einstein, these further distortions of the four-dimensional space being specified by the six components of a vector. Now the significant thing is this. On calculating the relations which must hold between the six components of the vector in order that the relativity condition may be satisfied, Weyl finds equations which are precisely identical with the electromagnetic equations of Maxwell, the six components in question now appearing as the three components of electric force and the three components of magnetic force.

Weyl's Electromagnetic Theory

It is not easy to explain in non-mathematical language what is the essential difference between Weyl's space and the old Euclidean space. We can best attempt it by treating Einstein's space as a half-way house. Returning for a moment to the two-dimensional analogy provided by the earth's curved surface, we know that the length of a degree of longitude decreases as we recede from the equator ; the ship turns north on its voyage from the Lizard to New York in order to take advantage of the shorter degrees of longitude up north. The planet going round the sun describes a curved path for a similar reason. According to Einstein's theory, a measuring rod changes in length as it moves about in a gravitational field—a two-foot rule is no longer two feet in length if taken from the earth to the sun ; it is because of this that the wave-length of the light represented by a definite spectral line when emitted at the sun's surface is different from that of the same light emitted on earth. The length of the rod depends only on its distance from the sun, being, in fact, proportional to

$$\left(1-\frac{2\gamma m}{rc^2}\right)^{-\frac{1}{2}},$$

where γ is the gravitation constant, m the mass of the sun, c the velocity of light, and r the distance from the sun. But in Weyl's space the length of such a rod does not depend solely on its position ; it depends also on the path by which this position has been attained. A rod of length l displaced parallel to itself through a distance dx, dy, dz, dt in the four-dimensional continuum may be supposed to experience a change of length dl defined by

$$dl = l(Fdx + Gdy + Hdz - \Psi dt),$$

where F, G, H, Ψ are quantities which need not at present be specified. If the rod is taken a journey from P to Q its whole change of length will be given by

$$\log \frac{l_q}{l_p} = \int_P^Q (Fdx + Gdy + Hdz - \Psi dt).$$

In Einstein's geometry the integrand is necessarily a perfect differential, so that the value of l_q/l_p depends only on the position of Q and P and not on the particular path selected from P to Q ; the condition that this integrand shall be a perfect differential is expressed by the six equations

$$\frac{\partial H}{\partial y}-\frac{\partial G}{\partial z}=0, \qquad -\frac{\partial \Psi}{\partial x}-\frac{\partial F}{\partial t}=0,$$
$$\frac{\partial F}{\partial z}-\frac{\partial H}{\partial x}=0, \qquad -\frac{\partial \Psi}{\partial y}-\frac{\partial G}{\partial t}=0,$$
$$\frac{\partial G}{\partial x}-\frac{\partial F}{\partial y}=0, \qquad -\frac{\partial \Psi}{\partial x}-\frac{\partial H}{\partial t}=0.$$

In Weyl's geometry, on the other hand, the integrand $Fdx+Gdy+Hdz-\Psi dt$ is not a perfect differential, so that the quantities on the left hand of the equations just written down do not vanish; they have values a, b, c, X, Y, Z different from zero, so that

$$\frac{\partial H}{\partial y}-\frac{\partial G}{\partial z}=a, \qquad -\frac{\partial \Psi}{\partial x}-\frac{\partial F}{\partial t}=X,$$
$$\frac{\partial F}{\partial z}-\frac{\partial H}{\partial x}=b, \qquad -\frac{\partial \Psi}{\partial y}-\frac{\partial G}{\partial t}=Y,$$
$$\frac{\partial G}{\partial x}-\frac{\partial F}{\partial y}=c, \qquad -\frac{\partial \Psi}{\partial z}-\frac{\partial H}{\partial t}=Z$$

These are precisely Maxwell's electromagnetic equations, F, G, H being the components of the magnetic vector potential, and Ψ the electrostatic potential. Turning back, we see that F, G, H, and Ψ are determined at any point by the rate at which a measuring rod of unit length changes its length as it passes through that point

When Einstein explained gravitation in terms of curvatures and special metric properties of space, the equations of his theory were found to be different from those of the old Newtonian theory. It was accordingly possible to make an observational test between the two theories, and this decided immediately and conclusively in favour of the theory of Einstein. There is no hope of establishing the truth of Weyl's theory in a similar way, for, as we have just seen, the equations to which it leads are precisely identical with the already universally accepted equations of Maxwell. Weyl's theory can only be judged by its inherent plausibility or the reverse.

Judged by this standard, everything seems to be in its favour. The luminiferous ether failed, partly because it left no room for gravitation, partly because its mechanism had to be supposed to be too elaborate for the facts to be explained The hypothesis of an ether led us to anticipate a whole series of different phenomena corresponding to different velocities through the ether, so that when these were not forthcoming, its advocates were compelled to elaborate a complicated theory by which all the forces of Nature were in collusion to make these different occurrences appear the same to us. The Einstein-Weyl geometrical theory escapes both these reproaches Both gravitation and electromagnetism fit perfectly naturally into their places. These two systems of forces correspond exactly and completely to the ways in which a four-dimensional geometry can differ from the simple geometry of Euclid. The observed forces of gravitation and electromagnetism correspond exactly to the most general forces which are possible, if "force" is interpreted simply as an illusion arising from a crumpling up of space. Consequently the observed phenomena of Nature are precisely those which ought to be observed —not one is missing and neither is there room for a single one more. There is now no collusion among the forces of Nature to conceal a whole series of unobserved phenomena: indeed, there could be no concealment because there is nothing to conceal. By its simplicity, its completeness, and its perfect agreement with the observed phenomena of Nature, the theory seems likely to take its place as our final interpretation of the "forces" of Nature.

We now see that the universe of Euclid, in which parallel lines never meet and in which two sides of a triangle are always greater than the third, was a simplified ideal universe. In the same way the universe of Aristotle and Plato, in which space and time are permanently distinct and essentially different in their natures, was a simplified ideal universe. Both universes were too simple to fit the facts, remove the unwarranted simplifications and we are left with a universe the geometrical properties of which are expressed by such equations as Einstein's gravitational equations (to which Newton's inverse square law gives a good approximation) and Maxwell's electrodynamical equations. Thus geometry, cleared of *all* unjustifiable assumptions, transforms itself into mechanics, both gravitational and electrodynamical A being who was born without any one of his five senses, but with unlimited geometrical reasoning powers, could deduce the general nature of the actual world without any experience of reality: he would anticipate that landslides, earthquakes, thunderstorms, and auroræ would occur, but he would know nothing about "forces," and would regard these phenomena merely as geometrical necessities.

Atomicity.

Although generalised geometry can predict and explain all the systems of forces of the universe, it has its limitations; there are features of the actual universe before which it stands powerless. Nothing in geometry can explain the essential differences between positive and negative electricity, or the atomicity of electric charges, so that the whole inner structure of matter, including the whole of chemistry, would be outside the scope of the intuitions of our supposed geometer.

Electric charges are a consequence of, or at least are associated with, a curving or crumpling of space, but so far as pure geometry goes there is no restriction on the extent of this crumpling, so that our geometer, reasoning from geometry alone, might expect to find charges of all possible amounts, whereas in actual fact

electric charges occur only in multiples of a definite unit, the charge of an electron. It is clear, then, that there is something more than geometry underlying the phenomena of Nature; the whole phenomenal universe may be geometry with restrictions if we like, but not merely the geometry which is obtained by generalising the geometry of Euclid until we can generalise no further. Space can be crumpled up qualitatively in all the ways known to geometry but not quantitatively; the uniformity of the electronic charge must in some way represent an absolute restriction on the measure of the crumpling.

Each particle of matter—each electron, let us say—occupies one point of space at any one instant of time, and the succession of these points will form a line in the four-dimensional space-time continuum—the "world-line" of the electron. In the neighbourhood of this world-line there is a deformation of the continuum due to the existence of the electron.

The near approach of two electrons or of any two charged particles is represented by a near approach of their world-lines in the four-dimensional continuum. Each world-line is surrounded by its associated deformation, and in regions in which the world-lines are near to one another the adjacent regions of the continuum will be doubly deformed.

A priori there are two possibilities open The first is that the two deformations are merely additive, just as, when two ships approach, each making its own wash (or deformation of the surface of the sea), the height of wash at any point is the sum of the heights of the washes made by the two ships independently. The second possibility is that, as there have been found to be restrictions on the amount of deformation associated with the two separate world-lines, there may be a further restriction on the deformation arising from their combination.

In actual fact the former alternative appears to prevail when one or both of the charged particles are "free" electrons, but the latter alternative when they are "bound" together; that is, when they are permanently describing orbits about one another. It is these latter restrictions that have given rise to the theory of quanta. Just as the restrictions associated with single world-lines give rise to an atomic constant e, the charge on an electron, so the restrictions associated with pairs of world-lines give rise to a second atomic constant. This is generally taken to be h, Planck's constant, but in many respects it is more appropriate to regard the product hC as the second constant, where C is the velocity of light. It is significant that hC is of the same physical dimensions as e^2 and so may be regarded as being the same thing as e^2 except for a numerical multiplier. Thus while the restrictions connected with one world-line introduce e, those connected with two world-lines, depending only on e^2, introduce no essentially new constant, whence it may reasonably be suspected that the two sets of restrictions are merely different aspects of one and the same set. It looks as though the atomicity of the quantum theory is only another aspect of the atomicity of electric charges.

Quantum Restrictions

We can perhaps best visualise the inner nature of the quantum-restrictions by going back to the analogy of the two ships making a combined wash which is in some way restricted to being of a certain height We have supposed each wash individually to be restricted; if the velocity of the ships is fixed, this requires that each ship shall be of a definite size (corresponding to each electron having a definite charge). How can we now put a further restriction on the total wash of the two ships at points where their washes overlap? Only, I think, by keeping the ships at a specified distance apart. At any rate this is the way in which the quantum-restrictions work. The normal hydrogen atom consists of a negative electron describing a circular orbit about a positively charged nucleus; the quantum-restrictions compel this orbit to keep an unvarying radius of $0{\cdot}53 \times 10^{-8}$ cm. When the atom is in an abnormal state, as, for example, when excited in a vacuum tube, the orbit, if circular, may have radii equal to 4, 9, 16, 25 . . times the radius of the normal atom Elliptic orbits also are possible, but only of quite definitely restricted major and minor axes. In actual fact the semi-major axis must be equal to one of the radii permissible for a circular orbit, while the ratio of the two axes must be one of a range of commensurable ratios. The orbits which are possible for the electron of the hydrogen atom are shown in Fig. 2. If it were not for the quantum restrictions, it would be impossible to exhibit these orbits in a diagram at all; orbits of every radius and of every eccentricity would be possible, just as they are for a planet or comet describing an orbit about the sun.

It will be understood that I have not approached the quantum theory by the road of its historical development. Planck originally discovered the existence of the quantum-constant h from a study of black-body radiation. The famous theorem of equipartition of energy showed that if the classical laws of dynamics were of universal validity, the whole energy of the material universe would at once degrade itself into radiant energy of infinitesimal wave-length. Planck showed that this conclusion could be avoided by supposing that the energy of radiating mechanisms changed only by complete quanta, the change of energy $W_2 - W_1$

being connected with the frequency ν of the radiator by the relation

$$W_2 - W_1 = h\nu.$$

He further showed that this supposition led to a law of spectral distribution of black-body radiation, the now famous Planck's law, which was found to agree excellently with the observed distribution. In this way the quantum theory came into being at the very beginning of the quarter-century we have under review.

Some years elapsed before Einstein showed that the same constant was of fundamental importance in the photo-electric effect, and it then began to be suspected that it might conceivably be fundamental to the whole of physics But it was not until 1913 that Bohr published the epoch-making paper which first suggested, and at the same time finally established, that this

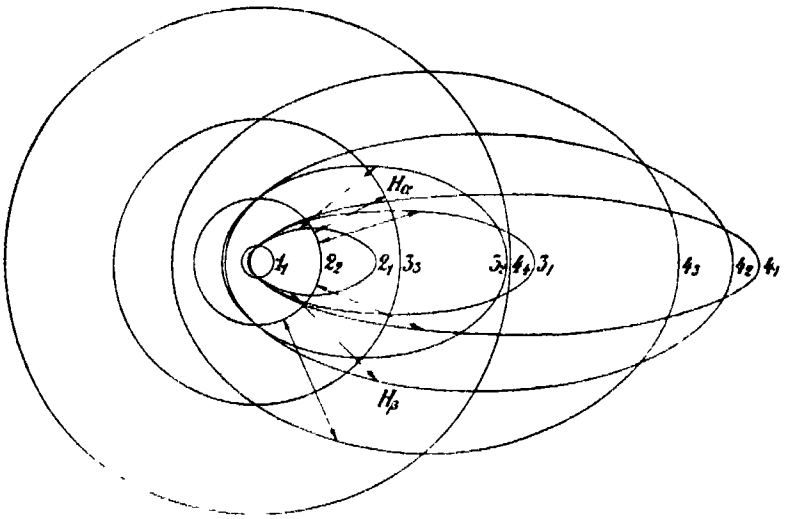


FIG. 2

constant held the clue to the structure of the atom and determined the scale on which the universe is built. To-night I have disregarded historical development altogether, and have tried to approach the theory in the simplest manner, I am trying to make it look natural. There can be no reasonable doubt that the quantum theory is essentially true, and so would appear perfectly natural to us if we could approach it with entirely fresh minds not already obsessed by erroneous ideas. But with our minds such as they are, the quantum theory as frequently presented does, it must be admitted, raise recollections of plausible conjuring performances If I were to state the argument by which Planck first arrived at the existence of the quantum, the inclination might well be to dismiss it as mere mathematical sleight-of-hand I agree it is still a bit surprising that the rabbit came out of the hat, but I have tried to show at least that there was so much room in the hat that almost anything might have emerged.

According to the Maxwellian electrodynamics an electron describing an orbit of any kind must necessarily radiate energy. We can calculate the rate at which energy ought to be radiated by the electron in the normal hydrogen atom; it is 0·46 erg a second. The resulting loss of energy would be compensated by a decrease in the radius of the orbit; we find that the rate of this decrease would be about 112 cm. a second, so that the atom ought to disappear altogether within a small fraction of a millionth of a second Thus it is the quantum-restrictions which give a permanent existence to matter

In conformity with the quantum-restrictions, the electron in the hydrogen atom describes an orbit of unvarying radius and so of constant energy. Maxwell's equations, as we have seen, would demand that radiation should be emitted and that the energy of the orbit should decrease accordingly. Here, then, we have a case where the requirements of Maxwell's theory and those of the quantum theory are in irreconcilable conflict It is the quantum theory which carries the day. Somewhere before we reach the most minute of all structures, Maxwell's theory fails and the quantum theory takes its place. For large scale phenomena the two theories coincide — a thunderstorm is the same thing for Maxwell's theory as for the quantum theory, just as it was the same thing for the old "one-fluid" theory as for the modern electron theory—atomicity is of no consequence when the number of atoms involved approximates to infinity.

In terms of space curvatures we may say that Maxwell's theory is represented by a continuous curvature or crumpling such as might be applied to a rubber membrane, while possibly the quantum theory may be represented by a so-to-speak "jerky" deformation which is the best that can be done with a scaly surface such as a crocodile skin. If we wish to cover the earth's surface with a membrane, it makes little difference, from the point of view of closeness of fit, whether we select rubber membrane or crocodile skin, but it makes all the difference if we are manufacturing a pair of gloves. The quantum theory represents, perhaps, a quality of space, or rather of the four-dimensional continuum, which is somehow analogous to scaliness in a skin.

As the normal hydrogen atom is already in its configuration of minimum energy it can emit no radiation. But under electric bombardment or in the presence of intense radiation, the electron may move to other orbits of energy higher than the minimum. Even now there can be no gradual change of energy, but there can

be spasmodic jumps from one orbit to another orbit of lower energy. According to Bohr's theory of atomic mechanism, the energy lost to the orbit at each one of these jumps is emitted in the form of monochromatic radiation. A jump from energy W_2 to energy W_1 results in the emission of radiation of uniform frequency ν where

$$W_2 - W_1 = h\nu,$$

h being the absolute constant of Nature already referred to. If λ is the wave-length of the radiation, $\lambda = C/\nu$, so that

$$W_2 - W_1 = \frac{hC}{\lambda}$$

We have already seen that hC is equal to Ke^2 where K is a numerical constant. The energy in an orbit of radius r (or, if elliptical, of semi-major-axis r) is $-\frac{1}{2}e^2/r$, so that if the jump is from an orbit of radius r_1 to one of radius r_2,

$$\tfrac{1}{2}e^2\left(\frac{1}{r_2} - \frac{1}{r_1}\right) = \frac{Ke^2}{\lambda},$$

and the wave-length of the radiation is given by

$$\frac{2K}{\lambda} = \frac{1}{r_2} - \frac{1}{r_1}.$$

Now if a is the radius of the normal hydrogen atom, the possible values for r_2 and r_1 are 1^2, 2^2, 3^2, 4^2 . . . times a, so that our formula becomes

$$\frac{2Ka}{\lambda} = \frac{1}{n_2^2} - \frac{1}{n_1^2}.$$

In actual fact a formula of this type, in which n_1 and n_2 are given all possible integral values, is found to give with the utmost exactness the wave-lengths of the light emitted in the complicated spectrum of the hydrogen atom. On putting $n_2 = 2$ we obtain the Balmer series of lines, of which the principal lines H_α, H_β, H_γ . . . form the most conspicuous feature in the ordinary hydrogen spectrum. The lines obtained by putting $n_2 = 1, 3, 4, 5$ . . . are mostly in the infra-red or the ultra-violet. Many of these have been observed, and there is no reason to doubt that the remainder are there, although at present beyond the range of observation.

So far we have considered only the circular orbits; there must, of course, be other spectral lines arising out of the possibility of the electron describing elliptic orbits. Exact analysis shows, however, that these latter lines coincide almost exactly with those already discussed. They would coincide perfectly if it were not that the mass of a moving electron depends on the velocity of its motion. As a consequence of this dependence of mass on velocity, the two sets of lines do not exactly coincide. Each line of the simple series previously discussed is replaced by a "fine-structure" —a bunch of lines quite distinct in fact, although so close together as to look like a single line in all save the most powerful spectroscopes. Sommerfeld has worked out the structure to be expected theoretically for these bundles of lines and obtains a most gratifying agreement with observation. This and other experimental tests give the most convincing proof of the accuracy of Bohr's theories of atomic mechanism.

We can gain a knowledge of the arrangements of the electron orbits in even the most complicated atoms by using the equation

$$W_2 - W_1 = h\nu,$$

which appears to be of universal validity. The frequencies ν of radiation can be measured, so that the energy-levels W_1, W_2 . . of the various possible orbits can be calculated. The method has been applied not only to discovering the arrangements of electrons in the atom, but also to discovering the energy-levels of the protons in the nucleus. At present the hydrogen atom and the positively-charged helium atom are the only structures which are completely understood, but there can be little doubt that in time the method will unravel for us the secrets of even the most complicated of atomic and molecular structures

Already Bohr has constructed a table, of which the first part is shown in Table I, in which he attempts to assign the different electrons in the atoms to the

TABLE I.—ELECTRON ORBITS

	1_1	$2_1 2_2$	$3_1 3_2 3_3$	$4_1 4_2 4_3 4_4$	$5_1 5_2 5_3 5_4 5_5$
1 H	1				
2 He	2				
3 Li	2	1			
4 Be	2	2			
5 B	2	2 (1)			
– –	–	– –			
10 Ne	2	4 4			
11 Na	2	4 4	1		
12 Mg	2	4 4	2		
13 Al	2	4 4	2 1		
– –	–	– –	– –		
18 A	2	4 4	4 4		
19 K	2	4 4	4 4	1	
20 Ca	2	4 4	4 4	2	
21 Sc	2	4 4	4 4 1	(2)	
22 Ti	2	4 4	4 4 2	(2)	
– –	–	– –	– – –	–	
29 Cu	2	4 4	6 6 6	1	
30 Zn	2	4 4	6 6 6	2	
31 Ga	2	4 4	6 6 6	2 1	
– –	–	– –	– – –	– –	
36 Kr	2	4 4	6 6 6	4 4	
37 Rb	2	4 4	6 6 6	4 4	1
38 Sr	2	4 4	6 6 6	4 4	2
39 Y	2	4 4	6 6 6	4 4 1	(2)
40 Zr	2	4 4	6 6 6	4 4 2	(2)
– –	–	– –	– – –	– – –	–
47 Ag	2	4 4	6 6 6	6 6 6	1
48 Cd	2	4 4	6 6 6	6 6 6	2
49 In	2	4 4	6 6 6	6 6 6	2 1
– –	–	– –	– – –	– – –	– –
54 X	2	4 4	6 6 6	6 6 6	4 4

various orbits permitted to them by the quantum theory. The numbers in the top line specify the orbits in terms of their principal and subsidiary quantum numbers. The numbers below are the numbers of electrons which follow one another round in these different orbits. It will be noticed that in the simpler elements there are never more than four electrons in the same orbit, although in the heavier elements six and afterwards eight electrons may inhabit the same orbit. The table is largely conjectural, but recent spectroscopic research has gone far towards establishing its essential accuracy When we remember that it is less than twelve years since Bohr first suggested that the quantum theory might provide the clue to the structure of matter, we must agree that the progress of the theory in these years has been remarkable.

The Nature of Radiation.

The quantum theory has been less successful in discovering the nature of radiation, although even here it has been beyond comparison more successful than any previous theory. To illustrate the difficulties of the problem, let us consider one single phenomenon—the X-ray photo-electric effect. A thin stream of electrons each moving with the same high velocity is allowed to impinge on a material target, and X-rays are emitted which carry off the energy destroyed by the collision These X-rays pass through a gas, and it is found that as soon as the process starts, atoms are ionised and shoot off electrons with a velocity equal to that of the original stream of electrons. Even if the density of X-radiation is so slight that, according to the old view of radiation, an atom would take years to absorb the energy necessary for ionisation, nevertheless ionisation is found to begin at once, energy being absorbed which is not only sufficient for mere ionisation, but also suffices in addition to endow the ejected electron with high velocity.

Such a phenomenon is of course totally inexplicable in terms of the luminiferous ether, or even in terms of Maxwell's equations. The quantum theory gives only a partial explanation. Since the frequency ν of the X-rays does not change with their passage through space, the equation $W_2 - W_1 = h\nu$ shows that the change of energy at the one end of the chain must be equal to that at the other. Thus as much energy is necessarily yielded up to one electron as is destroyed in another, but this does not touch the problem of the mechanism by which this energy is transferred.

Einstein at one time suggested that radiant energy was hurled through space tied up in indivisible packets like bullets from a rifle, but it has proved quite impossible to reconcile this suggestion with the optical phenomena of interference. A more recent hypothesis, also due to Einstein, calls for a revision of our conception of the action of an electric field on an electron.

According to the usual electrical theory, an electric force X acting on an electron of charge e and mass m for a time t produces a change of velocity equal to

$$\frac{Xet}{m}.$$

According to Einstein's recent theory of radiation, this is only true if X arises from a steady field or from a field which changes infinitely slowly. A force X which results from the incidence of radiation will in general produce no change of velocity at all in an electron. Indeed a bound electron is compelled to describe a fixed orbit with a prescribed velocity which cannot change, while a quite simple argument shows that it would be contrary to the fundamental equation of the quantum theory for a free electron to have its velocity changed by radiation. Einstein, following Bohr, supposes that under certain conditions a bound electron can have its velocity changed by a definite amount Q. This amount is not equal to Xet/m, but is determined by the position and motion of the electron in the atom to which it belongs; Q must be such as to move the electron into a new orbit which is also one of the permitted few. The chance of such a jump of velocity occurring is supposed to be

$$\frac{(Xet/m)}{Q}$$

This conception immediately explains the otherwise incomprehensible photo-electric effect as well as other puzzles in the behaviour of radiation. The difference between a strong and a weak electric field acting on an electron is no longer that the strong field produces a big change of velocity and the weak field a small one; it is that the strong field has a big chance of producing a change, and the weak field only a small chance of producing the same change. When radiation acts on a body containing a great number of electrons, the final result is the same on the new theory as on the old. But there is a difference of method which is similar to the difference in propulsion between a motor-car and a steam-engine; on the new theory the charged body is propelled by a succession of little kicks, whereas on the old theory it was propelled by a steady pressure.

I have tried to sketch the outlines of the changes which the past quarter-century has introduced into our conception of the nature of electric forces and of the electromagnetic field. You will agree with me that there have been giants at work in the field of pure electrical theory. When the history of present-day science comes to be finally written, the quarter-century we have just lived through will, so far as we can now judge, stand out as the period in which man first began to understand the true nature of electricity.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*



SATURDAY, MARCH 14, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 2889, VOL. 115]

Oceanic Research.

In his presidential address to the British Association at the Cardiff meeting of 1920, the late Sir William Herdman suggested that the time had come for a new deep-sea expedition on the scale of the *Challenger* voyage of 1872–74. This proposal was discussed at various Association meetings; a tentative scheme was approved and was then submitted for the consideration of other scientific bodies. The time, however, was regarded as inopportune and the proposal was not taken up. Now, it appears, the movement may come from the United States.

In 1923, Dr. H. C. Hayes, of the U S Navy, developed a very ingenious method of taking almost continuous ocean soundings by means of a sound-wave transmitted to, and reflected back from, the sea bottom This "echo-sounding" presented such possibilities for oceanographic surveys that definite suggestions were made for a national expedition, and, after considering these, Col. Theodore Roosevelt, the Acting Secretary of the U.S. Navy, summoned a meeting of representatives of government departments and extra-governmental establishments. This was held in July 1924, and was addressed by the Hon. Curtis D. Wilbur, Secretary of the Navy. A committee then prepared a report, which was adopted by the conference and sent to the Secretary.

The report recommends that a vessel, with officers and crew, should be supplied by the Navy. A scientific staff, consisting of an oceanographer, a biologist, and a geologist—all men of outstanding attainments—with six or more scientific assistants, will, it is expected, be provided from sources other than government funds. The cost of the first year's work, apart from the maintenance of the vessel and the salaries of the scientific staff, is estimated at about 57,000 dollars. How long the expedition will be away is not considered, but it is contemplated that a naval vessel will be permanently employed on oceanographic research.

The problems upon which the expedition is expected to concentrate are briefly outlined—they constitute a programme which is new, in some ways, and particularly attractive. The work of the *Challenger* was very comprehensive, but, in the main, it was biological in its attitude. Now, since 1872, the science of geophysics has been developed, and more attention is being directed to the morphology of the ocean floor. Existing oceanic soundings are so few that they are of little use in detailed studies, and so the method of finding the depth by echo-sounding must be largely used in any new oceanic expedition. During the last twenty years or so, a very extensive investigation into the subject of isostatic compensation in the earth's crust has been made by

the U.S. Coast and Geodetic Survey. The work accomplished has, however, been practically restricted to the North American continent, and its extension to the ocean floor and the deeps is most desirable.

Other geophysical problems demand close observations of the precise forms and positions of the deeps—the question, for example, of the downward warping of the ocean floor along the continental margins suggests the need for great numbers of new soundings in all regions. Evidence of submarine upheavals and dislocations, and of the occurrence and frequency of submarine earthquakes and volcanic eruptions, is urgently needed. There is necessity for a renewed investigation of the deposits on the ocean floor. Determinations of mean ocean depth in chosen places are needed Oceanic tides have scarcely at all been investigated, and even ocean currents are not so well known as they ought to be. The forms, heights, and velocities of ocean waves also require study.

Further, the great development of radio-telegraphy and telephony has suggested problems for which a much extended knowledge of electrostatic and electromagnetic fields in the atmosphere is required. Since the ocean covers five-sevenths of the earth's surface, most of this kind of investigation must be undertaken at sea The distribution of icebergs on the margins of steamship routes is already being studied by the U.S. Government, but a great extension of the field of investigation is necessary. Now, in addition to all these subjects of investigation, there are, of course, the routine physical and biological methods of research into the ocean water itself and the fauna of the sea floor. This would be done as a matter of course, but it is very interesting to see how "up-to-date" in its attitude to growing science is the programme for this new expedition.

It is recommended that the area of investigation should (at first) be the Gulf of Mexico and the Caribbean Sea. Then the research is intended to spread through the Panama Canal and to take in the North Pacific on one hand, and the North Atlantic on the other. At the present time oceanographic investigation of the Pacific Ocean is by far the most attractive side of the subject. There we obviously have ocean basins and continental margins *in the process of making* (for in the greater part of the Atlantic something like stability has been reached, and the problems there centre round sedimentation on the region of the continental shelf). A geophysical expedition dealing with the oceanic part of the earth's surface (for that is evidently what the present trend of scientific discovery suggests) cannot afford to concentrate on any relatively small part of the Pacific and Atlantic areas—the whole of the former region requires multitudes of ocean soundings at the very least. If, then, this big American expedition begins work very soon (and there is every likelihood that it will do so), the question of co-operation ought to be considered: it is a pity that such action was not discussed, and proposals of some kind made, at the conference.

At all events, the time is ripe for a consideration of the position of oceanographical investigation by Great Britain and other countries. For a long period now the objects of deep-sea expeditions have been very much the same as those of the *Challenger*—that is, the study of abyssal and pelagic ocean life, with the investigation of the physical conditions that influence the distribution and density of faunas and floras. Since the beginning of the work of the International Council for the Exploration of the Sea, oceanic research has had a strong fisheries bias, and, at the present time, a great deal of such investigation is actually in progress in the north European region: this is likely to develop still further its utilitarian and fishery objects, and its interest tends to become a very specialised and even an administrative one. We plead here for an interest which is much wider and should be purely scientific. During the last twenty years or so (and largely because of the original work of the International Council) oceanographic physico-chemical methods have been well developed. Hydrodynamical methods, on the mathematical side, are remarkably well developed and are far ahead of the observational side of the science. This is also the case with theoretical geophysical research: it waits for a sound and very extensive basis of observations, and that cannot be given by any amount of geological work on the land, for research on the five-sevenths of earth surface that is occupied by the ocean is urgently required.

Every consideration points, therefore, to deep-sea investigation on rather new lines, and the progress of geophysical and hydrodynamical research on one hand, and of oceanic meteorology on the other, suggest what these new directions ought to be. Now that a lead has been given by the proposed American naval expedition, it would be very gratifying if a similar British naval one could be planned out, and if it could be arranged that a large measure of co-operation of aims and methods were secured. In spite of all that has been done in Great Britain on fishery investigation, it is nevertheless true that scientific oceanography has been neglected ever since the time of the *Challenger* expedition, and we cannot see any reason why a small fraction of the resources and interests of our Admiralty should not be directed to the prosecution of pure oceanic research without a necessary utilitarian object.

Scientific Exploration in the Karakorum Mountains.

Paesi e Genti del Caracorum: Vita di Carovana nel Tibet Occidentale. By Giotto Dainelli. (Pubblicato sotto gli auspici della R. Società Geografica Italiana.) Vol. 1. Pp. viii+291+74 plates. Vol. 2. Pp. iv+323+95 plates. (Firenze: Luigi Pampaloni, 1924.) 120 lire.

THE Karakorum Mountains are of special interest, as they contain the greatest glaciers known outside the polar regions and Mt. Godwin-Austen, or K.2, the third highest summit of the Himalaya. Scientific knowledge of the country has been collected by many distinguished explorers, including the brothers Schlagintweit in 1854–6, Godwin-Austen in 1860–1, Sir Francis Younghusband in 1887, and Sir Martin Conway, who in 1892 traversed the full length of the three longest glaciers and mapped them. In 1913–14 the country was visited by an Italian expedition under Dr. Filippo de Filippi, who had accompanied the Duke of Abruzzi on his expeditions to the same region and East Africa. When de Filippi received the medal of the Royal Geographical Society for his share in these explorations, the two Asiatic expeditions with which he was concerned were described by Sir Francis Younghusband as the best led and scientifically equipped expeditions which had up to then worked in the Trans-Himalaya. The full narrative of the expedition will be given in a promised monograph by de Filippi. The present work consists of the journals of its geologist, Dr. Giotto Dainelli, and it records his personal experiences and observations. He is well known from his work in East Africa, reminiscences of which lead to his contrasts between the modest simplicity of African caravans and the large cavalcade and numerous companies of coolies of Asiatic expeditions. The work also expresses the fascination of this country as compared with tropical Africa, owing to the more advanced architecture, culture, and religious development.

The two volumes tell the story of the journey from Marseilles to Bombay, and thence through Kashmir and by the well-known road across the Himalaya by the Zogi La to Dras and to the Indus at Tolti and Skardu. Thence Dr. Dainelli made a series of expeditions through the Karakorum valleys. He reached the ends of the Baltoro and Biafo glaciers, which were surveyed by Sir Martin Conway. The nearest comparable height among the glacial endings given is that of the Biafo, which Dainelli puts at 10,049 ft. and Sir Martin Conway determined as 10,120 ft., so there had been no material movement of the end of that glacier in the intervening twenty years. Dr. Dainelli did no serious mountaineering in this district and Sir Martin Conway's maps of the glaciers are incorporated in the author's general map. Later on, in the north-eastern Karakorums, Dr. Dainelli explored some less-known regions, including the Rimu Glacier, one of the sources of the Yarkand River, and there the expedition added materially to geographical knowledge. After many journeys in the valleys south of the main glacial region of the Central Karakorums, the expedition proceeded to Leh. Dr. Dainelli shows the charm of that country by many photographs of the picturesquely placed monasteries or gompas, and his descriptions of the religious dances.

From Leh the expedition proceeded north-westward to Depsang, on part of the way using yak, which the author describes as the camel of the mountain deserts. He visited some little-known valleys, and, among other features of interest, various hot springs and salt lakes. In this district Dr. Dainelli crossed the routes of the Schlagintweits, whose work he praises highly, though in parts of this country the latest Indian map was so sketchy that he could not determine his place on it. From Depsang he explored the Ciong Cumdan and Rimu Glaciers, with their interesting moraines, glacial lakes, and stratified ice. Thence following the Yarkand River, the expedition descended, with obvious regret, from the mountains to the monotonous steppes of Turkistan. During the return journey the explorers were arrested at Moscow as German spies, but promptly released on the intervention of the Italian Ambassador; they proceeded through Petrograd and Stockholm to Berlin, which the author describes as in October 1914 apparently following its normal life.

The two volumes of Dr. Dainelli's experiences give an interesting account of the conditions under which the work of the Filippi Expedition was conducted and show what great opportunities its members enjoyed. The author describes the work as a faithful journal of his share in the expedition, and it gives useful observations on the topography and people Its value as a work of reference is much lessened by the absence of an index, which would be especially useful where the spellings in the text and map differ, as in Olang and Olting. The expedition worked near an area of special interest in reference to the structure of Central Asia. The observations of this expedition may resolve the different interpretations of the Mustag-ata which, according to Suess, is a transverse meridional chain breaking unexpectedly across the main trend of the Asiatic ranges. This conclusion was rejected by the late Sir H. H. Hayden, who did not, however, fully explain the facts of which Suess's view was offered as an interpretation. There is but little information on these questions in the journal, though the expedition obviously collected much new material. Dr. Dainelli remarks, for example, that the Museum of San Marco

would not have space to hold their collections of fossils; but as to what the fossils are we must wait for the later monographs. Similarly, the rocks are often graphically described; but they are not identified, and the picturesque pinnacles and masses of limestone shown in the photographs are of unstated age.

The technical work of the expedition is being published in 13 parts, dealing with the geology, geography, palæontology, petrology, ethnology, botany, zoology, and geodesy. The only report yet issued is that on the glaciers, a volume with a fine atlas by Dr. Dainelli. His journal is illustrated by numerous beautiful photographs and a four-sheet topographic map on the scale of 1-750,000, which is a valuable addition to the geography of the central and north-eastern Karakorums. J. W. G

Studies in the History of Medicine.

(1) *Essays on the History of Medicine.* Presented to Karl Sudhoff on the occasion of his Seventieth Birthday, November 26, 1923, by Sir T. Clifford Allbutt, Arturo Castiglioni, Friedrich Dannemann, Paul Diepgen, Erich Ebstein, Fielding H. Garrison, Ernst Howald, Arnold C. Klebs, E. O von Lippmann, Max Neuburger, Sir Humphry Rolleston, Henry E. Sigerist, Charles and Dorothea Singer, W G. Spencer, Georg Sticker, E. C. Streeter, Lynn Thorndike, G. A. Wehrli, and Edward Theodore Withington. Edited by Charles Singer and Henry E. Sigerist. Pp. v+418+24 plates. (London: Oxford University Press; Zurich: Verlag Seldwyla, 1924.) 42*s.* net.

(2) *The Doctor's Oath: an Essay in the History of Medicine.* By W H. S. Jones. Pp. vi+62. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

(3) *A Pioneer of Public Health—William Thompson Sedgwick.* By E. O. Jordan, G. C. Whipple, and C.-E. A. Winslow. Pp. xvi+193+5 plates. (New Haven: Yale University Press; London: Oxford University Press, 1924.) 18*s.* 6*d.* net.

(1) THE *Festschrift* dedicated to Prof. Karl Sudhoff on the occasion of his seventieth birthday consists of eighteen essays contributed by writers from England, the United States, Germany, Austria, Switzerland, and Italy. The essays, eight of which are in English, nine in German, and one in Italian, have been classified by the editors into the five groups of antiquity, Middle Ages, Renaissance, modern times, and general subjects respectively.

The first group contains essays on prehistorical attempts to prevent and stamp out epidemic disease, by Dr. Georg Sticker of Würzburg, the work of Philolaus, by Dr. Ernst Howald of Zurich, and the scientific treatises ascribed to Theophrastus, by Dr. Lynn Thorndike of Cleveland. In the section devoted to the Middle Ages, Dr. E. O. von Lippmann of Halle writes on the history of alchemy; Dr. Diepgen of Freiburg discusses the influence of the Middle Ages on the progress of medicine; Dr. and Mrs. Singer deal with the origin of the medical school of Salerno, which they show to be the result of combined Greek, Latin, Jewish, and Saracen influences; Dr. E. T. Withington gives an account of Roger Bacon's work entitled "On the Errors of Physicians"; and Prof. Arturo Castiglioni devotes an illustrated article to blood-letting in the arms of the Manfiedi, lords of Faenza. The third section contains papers by Dr. Henry E. Sigerist of Zurich on the birth of Western medicine; fifteenth-century miniatures of extra-mural dissection by Dr. E. C. Streeter of Harvard and Dr. Charles Singer; the "Practica of Gianmatteo Ferrari da Gradi, editio princeps," by Dr. Arnold C. Klebs of Noyon; and the "Epitome" of Vesalius on vellum in the British Museum, by Mr. W. G. Spencer.

Modern times are represented by contributions from Sir Humphry Rolleston on the reception of Harvey's doctrine of the circulation of the blood in England as exhibited in the writings of two contemporaries, namely, Thomas Winston (1575–1655) and Henry Power (1623–1668); from Colonel Fielding Garrison, on the newer epidemiology; and from Dr. Erich Ebstein of Leipzig on Frank Joseph Gall. The last group contains papers by Prof. Max Neuburger of Vienna on the history of the problem of Nature healing, parallelism in the development of the natural sciences and therapeutics, by Dr. F. Dannemann of Bonn, and the essence of folk medicine and the necessity for its historical study, by Dr. G. A. Wehrli of Zurich.

A bibliography of Prof. Sudhoff's works on the history of medicine, compiled by Dr. Sigerist, is appended.

No higher praise can be given to the volume than by saying that it is worthy of its recipient, whose services to the history of medicine are gracefully acknowledged in the preface by Sir Clifford Allbutt. The work is well printed, and accompanied by numerous excellent illustrations.

(2) Mr. W. H. S. Jones's scholarly work on the Doctor's Oath will interest alike the historian of ethics and the medical practitioner, inasmuch as medical ethics and the medical etiquette of the present day are based upon this famous oath.

After a brief account of the manuscripts of the Hippocratic collection, with an enumeration of the best manuscripts containing the oath, the Greek text of the Pagan Oath is given, with the English translation and critical footnotes. The chief variants in the later manuscripts are noticed, and are followed by a full

transcription of the Milan manuscript Ambrosianus B 113, which contains both the pagan and the Christian oath. The Greek text of the Christian modification of the oath, which in two manuscripts is written in the form of a cross, differs from the pagan oath in its omission of (1) reference to the pagan deities, (2) of all clauses in which preferential treatment is promised "to my teacher, his sons, my sons, and to those who have sworn allegiance to the physician's law," and (3) reference to a reward for instruction.

The Arabic text is also reproduced, as well as two Latin translations ascribed to N Perotti and Nicholas of Regium respectively.

In the subsequent commentary Mr. Jones points out that though the first certain reference to the oath is in the preface to Scribonius Largus, who flourished in the reign of Claudius, there is a possible allusion to it in the *Thesmophoriazusæ* of Aristophanes, *i.e.* as early as 400 B.C. The two versions of the oath, pagan and Christian, and their variants, suggest that the document had a wide circulation. The extant evidence does not conclusively prove that the oath was ever actually administered, and Mr. Jones suggests that it was "a counsel of perfection expressed in the form of an oath, just as many sepulchral epigrams in the Greek anthology are literary efforts which have never appeared on tombs."

In an appendix Mr. Jones compares the oath with the addresses to medical students in the old medical books of India, and reproduces the oaths still in use at the Faculties of Medicine at Montpellier and Glasgow.

(3) The memoir on the late Prof. William Thompson Sedgwick, who has been called the "Father of Epidemiology in the United States," consists of a series of essays by his former pupils, Prof. E. O. Jordan, G. C. Whipple, and C.-E. A. Winslow, preceded by an introduction by Prof. Sedgwick's widow. In the first essay, which deals with the public health movement in the 'seventies, the writers, after acknowledging the indebtedness of the United States to British sanitary science, point out that public health in the 'seventies was almost wholly concerned with the problems of the non-living environment. During Sedgwick's lifetime the public health movement assumed a biological character as the result of Pasteur's researches, and the way was laid open for the development of bacteriology and immunology.

In the succeeding essay, which is entitled "The Gate of Knowledge," an account is given of Sedgwick's early life. Though he registered as a medical student he never qualified as a medical practitioner, but devoted his whole career to biology, epidemiology, and public work. His most important achievement in the field of public health, of which an account is given in the following essays, was his investigation of a series of typhoid epidemics in 1894 which occurred in Massachusetts. His next most important contribution to public health science was the development of laboratory methods for the study of the microbiology of air, water, ice, and milk. He also paid much attention to the subject of food sanitation and conservation, and laid stress on the importance of statistics in epidemiology and of sanitary engineering, chemistry, and biology in the prevention of the chief communicable diseases.

Finally, Sedgwick was well known as a lecturer in subjects relating to public health not only in the United States but also in Great Britain, where he acted in 1920 as an exchange professor in the Universities of Leeds and Cambridge. The volume contains two appendices, consisting respectively of a bibliography of Sedgwick's writings and a list of his pupils.

Applied Elasticity.

Applied Elasticity. By Dr. John Prescott. Pp vii + 666. (London: Longmans, Green and Co., 1924.) 25*s* net.

A STUDY of elasticity lying midway between that provided by Love in his "Theory of Elasticity" and by Morley in his "Theory of Structures and Properties of Materials" has long been required—a book, in fact, for the mathematical engineer The present work, as its title indicates, is an attempt to fill that niche, and it contrives to do so with considerable success Incidentally it is an exposure of the narrowness of the field that has been explored mathematically with any certitude.

The first three chapters deal with the analysis of stresses, the establishment of the equations, and a few particular solutions. These are very clearly expounded. Then follows a chapter on the empirical basis of elasticity. Considering the fundamental importance of this question and how necessary it is to realise the limitations involved in the basic assumptions and therefore imposed on the results of the theory in practice, it would be reasonable to expect a considerable chapter devoted to this question. Out of nearly 670 pages, this chapter consists only of 4 pages. The next seven chapters deal with rods under tension and thrust, in torsion, rods in longitudinal and torsional oscillation, and curved rods in equilibrium. Following a chapter on spheres and cylinders come four on thin plates under various conditions of stress and one on rotating discs.

It is apparent at once that, roughly, the field amenable to mathematical analysis narrows itself down to a treatment of the simple geometrical forms—the line, the plane, the sphere, and the cylinder. Even in these

regions it is not at all apparent how far the results obtained have actual validity. When in design work, factors of safety—or ignorance—of 5, 6, and 7 are common, it cannot be expected that a piece of analysis, however beautiful or elaborate, will carry conviction unless point by point the deductions can be checked directly or indirectly by experiment. The present work, we venture to think, would have been considerably enhanced by a larger proportion of space being devoted to experimental comparison, especially for a work on applied elasticity. The limitations of the theory of Chapter vi., for example, dealing with the buckling of struts, to choose only one case, would have been apparent had some of the published results of such tests been introduced for comparison. These would have enabled one to appreciate how far the simplifications involved in assuming idealised pin-joints, homogeneity of material, and lack of eccentricity generally are reflected in the calculations After all, it is vitally important to know how far applied elasticity can be relied upon for a prediction.

The author has apparently confined his attention deliberately to certain groups of questions. There is no mention of the many applications of elasticity to aeronautics, to wing and fuselage structures, or to twisting and vibration of propeller blades But we must not be over-critical. He has undoubtedly produced an excellent and important contribution to the subject, not merely in the old matter which he has presented in new and refreshing form, but also in the many original investigations here published for the first time. We are grateful for it.

Our Bookshelf.

Handbuch der allgemeinen Chemie Herausgegeben von Prof Wilhelm Ostwald und Prof. Carl Drucker. Band 4: *Das Leitvermögen der Lösungen.* Von Prof. Paul Walden Teil 1: Allgemeines, Grundlagen der Leitfahigkeitsmessungen, Methoden, Elektrolyte und Lösungsmittel, Uberführungszahlen, Ionenchemie. Pp. ix+383 17 marks. Teil 2 und 3: Zahlenwerte des Leitvermogens in wässerigen und nichtwasserigen Losungen; Folgerungen, Gesetzmässigkeiten, Anomalien, Anwendungen. Pp. vi+346+v+397. 47 marks. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924.)

THE fourth "volume" of Ostwald's "Handbuch der allgemeinen Chemie" consists of three parts, under the general heading of "Conductivity of Solutions." The first of these parts deals with methods of measurements, and general questions, such as the hydration of ions, and concludes with a long section on transport-numbers and ionic mobilities. The second part contains the numerical data in reference to conductivity in aqueous and non-aqueous solutions. The third part deals with regularities and anomalies, as well as the application of conductivity-measurements to the study of physico-chemical problems.

A quarter of a century ago, it was possible to deal fully with all these questions in a single small monograph. Thus Kohlrausch's "Leitvermögen der Elektrolyte," published in 1898, contained only 227 pages, including the table of contents and tables of logarithms, etc. The three sections of Prof. Walden's book cover 383, 347, and 397 pages respectively, apart from title-pages, etc., giving a total of well over 1000 pages. Like so much other German literature of this kind, the book is amazingly complete. Every paper dealing with the subject appears to have been noticed, and even the most distant applications are discussed with full references to the relevant literature. Thus an organic chemist who is interested in free radicals or in carbonium salts will find the relevant data duly catalogued. It is impossible not to admire the patience and skill of the author in compiling so complete a work, and its value to workers and teachers cannot be exaggerated. Its very completeness, however, makes it more suitable for use as a work of reference than as a text-book for students, unless as readers they possess the same amazing patience that the author has shown as a writer. One of the principal uses of the book will, however, be as a mine of information for those who are responsible for teaching the subject, and in this way its publication may prove of real value even to the elementary student, but it would be an alarming prospect if so complete a volume should be taken by his examiners as indicating what the scope of his knowledge should be.

The Military Uses of Astronomy. By Major F. C. Molesworth Pp. xii + 112 + 2 plates. (London: Longmans, Green and Co., 1924) 3*s.* 6*d.* net.

THE main impression created by reading Major Molesworth's handbook is that the task undertaken is rather a difficult one. Its object is to explain the fundamental principles of astronomy, with practical application to the simple problems which present themselves to the soldier without requiring the use of instruments. The knowledge demanded is modest enough, but to convey it in an accurate and attractive form is not easy. With the necessary deductions for full-page diagrams and so forth, this book occupies less than eighty-five pages, and, partly from its brevity, the treatment of the subject appears rather unsatisfactory. The needful familiarity with actual problems can only be gained by assiduous practice, and it seems doubtful whether Major Molesworth's little work will provide the stimulus to bring out the necessary effort.

In spite of Sir W. R. Birdwood's foreword, it seems but fair to recognise that the military uses of simple naked-eye astronomy are strictly limited. It is inconceivable that any serious operation should be left to the chances of a fine sky. There is no apparent reason why, in normal circumstances, the watch and the compass should not be used for the purpose of determining time and direction. In cases of emergency, as, for example, the escape of prisoners, readiness in making use of astronomical indications may be an invaluable resource, but only when more orthodox and trustworthy methods are not available.

This is not to be understood as discouraging in any sense the study of the elements of astronomy, which can be recommended as a thing fascinating in itself and

specially valuable alike to soldiers and to all others who are liable to find themselves removed from the normal conditions of civilised life. But it has no value which is exclusively military, and a broader foundation is desirable than will be found in this book if the more valuable sequel of practical observation is to be expected.

It should be mentioned that a special feature of the work is a set of diagrams giving for every 10° of latitude from 70° N. to 40° S. the bearing and altitude of the sun throughout the year. Something better in the way of star maps than the plates at the end of the book could easily have been provided.

A Manual for Spraying. By K. L. Cockerham. Pp. xi + 87. (New York: The Macmillan Co., 1923.) 7*s.* net.

THIS little book on spraying is intended as a reference book and guide for practical men. It is exceedingly brief, consisting of a short account of various types of spraying machines, including dusting apparatus; descriptions of and recipes for the more commonly used spray fluids; and a series of tables of insect and fungus pests, arranged under crop headings, giving the kind of injury caused by each pest and the spray recommended for its control. Unfortunately, the subject does not lend itself to quite such cut-and-dried treatment. The identification of a pest from a description of the injury, which seldom exceeds five or six words in length, is rarely likely to be successful. Moreover, the instructions for making up the spray fluids are in some cases so brief as to be incomprehensible Chemical formulæ are used to excess, frequently without any clear indication of the ordinary name of the substance; and inaccuracies and misstatements are inexcusably numerous. What is the fruit-grower to make of the following, with reference to Bordeaux mixture: "The liquid should be thoroughly tested for excess of $CuSo_4$ and $Ca(OH)_2$. If it does not respond to these tests it is unfit for the purpose for which it is intended"? Under the heading of crude petroleum we get the information: "Specific gravity of crude petroleum ranges from 1·049 (A) (ethane) to $0{\cdot}775^{18°}$ (hexadecane). Boiling-point of ethane as a solid is −86°." Sulphur dioxide has "specific gravity 1. 433680°. 2. 2639(A)." Directions for the use of nicotine sulphate are included, but not for nicotine. Many similar quotations could readily be given. If the author had left out most of the "chemistry" and devoted the space to some elaboration of the spray fluid recipes, the book might have proved useful to the growers and farmers for whom it was written. As it is, it cannot be recommended as helpful. C. T. G.

Refraction of the Eye: including Elementary Physiological Optics. By Dr. Charles Goulden. Pp. xii +276. (London: J. and A. Churchill, 1925.) 10*s.* 6*d.* net.

THE author tells us that this book is the outcome of a series of lectures which he has given at the Moorfields Eye Hospital to candidates for the new Ophthalmic Diploma of the Conjoint Board of England, and that its object is to give an exposition in as elementary a way as possible of the facts upon which the study of the refraction of the eye is based.

We may say at once that the book seems to meet these requirements in an admirable way. The headings to the seven chapters are: optics; the optical constants of the eye; the eye as an optical instrument; errors of refraction; the ophthalmoscope; retinoscopy; muscular anomalies. In this type of book the student is apt to find that the optics and mathematics are not so elementary as the author supposes; he will find, however, in Dr. Goulden's book, that the mathematics required can quite safely be called elementary, and the descriptions are all so particularly lucid that he will find little difficulty in at once grasping the facts The diagrams, of which there are one hundred and eighty, call for special praise; they are bold and clear and the lettering could not be improved upon.

It is a book that can be highly commended, not only to those whose immediate object is the negotiation of an examination test, but also to many who are well advanced along the road of ophthalmic practice and have not recently polished up such knowledge which is fundamental to the thorough understanding of much of their work. There is a very full index, the type and general get-up are excellent, and we may confidently predict a long life in future editions

Practical Forestry: from a Workman's Point of View. By A. C. Drummie. Pp. xii + 340 (London: G. Routledge and Sons, Ltd., 1924) 7*s.* 6*d* net.

THIS book is written "from a workman's point of view," and is in great measure the outpouring of one discontented with the present conditions of society in England; as such it may be left to the criticism of sociologists. As regards practical forestry, it contains nothing new or even freshly put, the matter being ill-arranged and mixed up with discussions on subjects the connexion of which with forestry is not obvious. The author, for example, "trusts readers will excuse a few remarks on the formation of coal," and proceeds to air his views: "Why is coal put between species of stone or rock? Because the Almighty put it there, and no expert or scientist breathing will ever make the writer believe otherwise." This book is unsuitable for forestry students or woodmen who require accurate description and scientific method in their manuals of instruction. It merits, however, the attention of both landowners and educationists, as its perusal shows how much remains to be done in the school and in the lecture hall to enlighten skilled workmen and artisans concerning the real aims of science.

Medical Hydrology: Outlines for Practitioners and Students. Based upon Lectures given at the University of London. By Dr. R. Fortescue Fox. Pp. viii + 136. (London: J. and A. Churchill, 1924.) 6*s.* net.

THE application of various waters in the prevention and cure of disease is one of the oldest therapeutic measures known to medical science, and in the past has been mainly empirical. In his outlines of medical hydrology, Dr. Fortescue Fox explains briefly the properties and actions of waters and discusses the rationale of treatment by their application. His conclusions are summarised in a series of aphorisms, the dogmatic wording of which is justified in the preface. The book will be useful to practitioners in exercising a choice of spas for the treatment of chronic disease.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

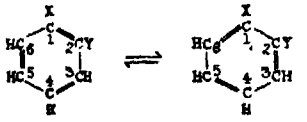
Graphitic Conduction in Conjugated Chains of Carbon Atoms: A Contribution to Armstrong's Theory of Chemical Change.

THE view put forward by Armstrong in 1885, that "chemical action is reversed electrolysis," has been brilliantly vindicated in the field of inorganic chemistry, especially by H. B Baker's experimental verification of the bold prediction that highly purified water will not determine the explosion of hydrogen and oxygen. In organic chemistry similar evidence in favour of Armstrong's theory has been afforded by the proof that a catalyst is needed even to effect the transfer of an atom of hydrogen from one part of the molecule to another in prototropic compounds such as ethyl acetoacetate or nitrocamphor

Whilst, however, it is easy to recognise that, in a chemical action between non-electrolytes, the catalyst may play the part of the *electrolyte* in a battery, and that the non-electrolytes themselves may act as *depolarisers* to the ions liberated by electrolysis, it has always been difficult to discover, in reactive systems from which metals in every form are absent, any analogue to the *metallic conductor*. Thus, we can picture the isomeric change of phenylchloroamine into parachloroaniline, $C_6H_5 \cdot NHCl \longrightarrow Cl \cdot C_6H_4 \cdot NH_2$ (in which atoms of hydrogen and chlorine change places under the influence of hydrogen chloride), as depending on a process of electrolysis whereby the catalyst is resolved into hydrogen and chlorine, the *electrolytic hydrogen* being depolarised by the chlorine which it displaces from the side-chain, and the *electrolytic chlorine* by the hydrogen atom which it displaces from the para-position in the ring This explanation, however, although complete from the chemical point of view, fails to explain the electrical action, since, in the absence of metallic conduction in the aromatic nucleus, it would leave a surplus of two electrons in the para-position and a deficit of two electrons in the side-chain, thus

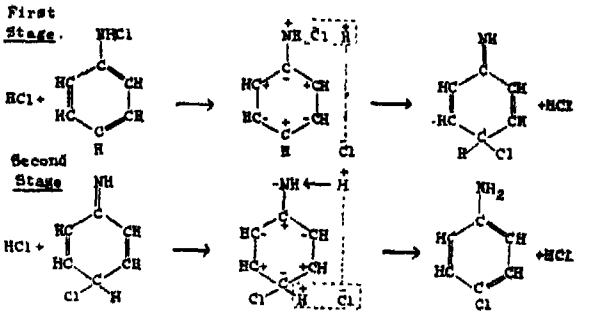
$$C_6H_5 \cdot NHCl \longrightarrow \overset{-}{Cl} \cdot C_6H_4 \cdot \overset{+}{N}H_2.$$

No method of discharging these two poles has, so far as I know, been suggested hitherto; but the fact that chemical changes, and especially isomeric changes, involving distant atoms are so peculiarly characteristic of aromatic compounds, indicates that some special mechanism (producing effects equivalent to metallic conduction) must exist in these systems to render such actions possible. From a purely chemical point of view, Kekulé so long ago as 1872 attributed to the bonds of aromatic compounds a peculiar mobility, which was not found in compounds of other types, when he found it necessary to explain the identity of the 1 : 2 and 1 : 6 derivatives of benzene by a spontaneous interchange of single and double bonds, as in the following scheme:



This interchange of bonds was not regarded, however, as conferring any special electrical properties on the molecules in which it took place. A similar mechanism was used by Lapworth in 1898 to explain the facility with which hydrogen and other radicals can wander between alternate atoms in unsaturated and conjugated compounds. This was attributed to the fact that, at each stage in the migration, the valencies can be adjusted by an interchange of bonds as in the scheme suggested by Kekulé. Thus when the hydrogen and chlorine in phenylchloroamine change places, the *chlorine* was supposed to wander first from the side-chain to the ring, with a simultaneous interchange of the alternate single and double bonds in the intermediate chain of atoms. The original arrangement is, however, restored by a second interchange of single and double bonds, when the *hydrogen* wanders in the reverse direction from the ring to the side-chain

Lapworth suggested further that the radicals probably migrate *in the form of ions*, but did not put forward any mechanism for the transference of the electric charges left behind by these ions on the aromatic nucleus. If, however, we now add to the electrolytic theory of isomeric change as set out above, the view (based upon the electronic theory of valency) that *at each stage of the action the intermediate double bonds of the conjugated system are ionised*, in the manner suggested in my paper on "The Polarity of Double Bonds" (Jour Chem. Soc., 1923, 123, 822-831), it will be found that the oscillation of double and single bonds, in the manner postulated by Kekulé and by Lapworth, has supplied the one feature that was needed in order to bring this interpretation into complete harmony with Armstrong's dictum, since the oscillation of bonds makes it possible for electric charges to be handed from one end to the other of a conjugated system, without any simultaneous migration of the intermediate atoms, *i.e. by a process which is analogous to metallic and not to electrolytic conduction*. The isomeric change of phenylchloroamine can therefore be represented as follows:



The chain of molecules of the catalyst through which electrolysis proceeds is here represented by two lines, thus, $\overset{+}{H} \ldots \overset{-}{Cl}$, and, following Lapworth, the transference of the halogen is represented as preceding the transference of hydrogen, but the ionisation of the intermediate system of conjugated double bonds, first in one sense and then in the other, now prevents the accumulation of electric charges at the two poles. It is, therefore, at last possible to formulate a scheme which is just as satisfactory from the electrical as from the chemical point of view, since it reproduces in almost every detail the mechanism of an electric battery, with the possible exception of the precise way in which metallic conduction is effected.

The polarities of the carbon atoms of the ring, as shown in the first stage, are the opposite to those normally developed in derivatives of aniline; and a similar reversal is seen in the polarity of the chlorine, which is usually split off in presence of water as a *positive* ion, *e.g.* in combination with negative hydroxyl

as hypochlorous acid, or (if hydrogen chloride is present as well as water) in combination with a negative chlorine ion as gaseous chlorine. It is, therefore, suggested that the polarities shown above are induced by a cathodic reduction of the chlorine of the chloroamine, accompanied by a simultaneous anodic chlorination of the *para* CH group, and that these conditions are sufficient to produce a reversal of the normal polarities of the system.

In this connexion it is of interest to recall the fact that X-ray analysis has shown that the transparent non-conducting crystals of *diamond* are made up of quadrivalent atoms of carbon linked together tetrahedrally, just like the atoms of a saturated organic compound of the aliphatic series; but in the case of *graphite* it has confirmed the view, already established by chemical methods, that the conducting crystals of this form of carbon are built up from a network of hexagonal rings, of the same type as the conjugated systems of aromatic compounds, in which the carbon-atoms are virtually tervalent. The suggestion that conjugated chains of carbon atoms, united by alternate single and double bonds, can perform the function of a metallic conductor is therefore in harmony with physical as well as with chemical observations. Since, however, the temperature coefficient of conductivity of graphite is positive, whilst that of metals is negative, and since, moreover, we can now assert that the structure of the crystals and probably the mechanism of conduction is quite different in the two cases, it would be wiser to describe the transference of electricity through conjugated chains of carbon atoms as *graphite conduction*, rather than as metallic conduction, and this term has therefore been used at the head of this letter.

T. M. LOWRY

54 Bateman Street, Cambridge.

Influence of Radiation on Ionisation Equilibrium.

IN considering ionisation equilibrium of the type $M \rightleftarrows M^+ + e - U$, the usual method adopted is to write down the entropies of M, M^+, and e from the quantum theory, and then the law of reaction isochore is obtained from the equation $S + S' - s = -U/T$. In this way we obtain the law of ionisation equilibrium

$$\log \frac{x^2}{1-x^2} P = -\frac{U}{2{\cdot}3RT} + \frac{5}{2} \log T - 6{\cdot}5. \quad (1)$$

The system is regarded as unary (one-component), *i.e.* all the reacting electrons as well as M are derived from the ionisation of M, but when there is excess of electrons, the system is binary and the equilibrium is expressed by the form first given by H. N. Russell, namely,

$$\log \frac{x}{1-x} \cdot \frac{x'}{1+x'} P = -\frac{U}{2{\cdot}3RT} + \frac{5}{2} \log T - 6{\cdot}5. \quad (2)$$

The process is regarded as an abrupt one, M-atoms passing directly under the influence of heat to the M^+-stage, without going through the intervening metastable states. Darwin and Fowler have attempted to include these intervening states by adding to the right-hand side of equation (1) a function $B(T)$. Prof. Russell has pointed out that neither equation (1) nor (2) can be regarded as final, because it fails to take account of the possible influence of radiation and excitation of higher states. We may introduce the matter in the following way. Suppose we have a mass of sodium-vapour in the solar chromosphere. Then the ionisation of sodium atoms is determined not only by the temperature of the chromosphere (say 5000° C), but also by the intensity of photospheric radiation of wave-length λ less than the wave-length of the limit of the P series, passing through these sodium atoms. This radiation has a higher temperature than the local temperature; hence, as was first pointed out by Milne, we have no thermodynamic equilibrium in the solar chromosphere. The excited states are produced under the joint influence of temperature of the chromosphere and of the photospheric radiation passing through the chromosphere. To the same class belongs the absorption experiments of Wood and others, in which a column of sodium or other vapour is acted on by light of much greater intensity than what would be produced at the temperature of the absorbing gas. Here all the excited atoms, or ionised atoms, are produced by light only, and almost none are due to temperature.

The general problem has been thus attacked. In all photochemical reactions the equilibrium is determined by the intensity of light, and in treating these cases from the point of view of the phase rule, Smits expressed the opinion, without however giving his reason, that the ordinary Gibbs formula, $F = C + 2 - P$, must be replaced by $F = C + 3 - P$. We, however, arrive at the same result by assuming that the number of components has increased by one, the photochemically active light being regarded as a new and independent component. In other words, when a normal sodium-atom passes to the $2p$-stage by absorbing the $h\nu$-pulse of D-radiation, then either the excited atom of sodium or the pulse of light may be regarded as a new component, except when the D-light is derived from the effect of temperature prevailing in the gas. In the latter case, the system is a system of one component, as in the corresponding case of free electrons in equation (1).

We thus regard excited sodium-atoms as a compound, in a special sense, of normal sodium-atoms and D-pulse. It has been possible to deduce the equilibrium conditions in such cases by combining the methods given by S. N. Bose (*Zs. f. Physik*, vol. 27, p. 384) and P. Ehrenfest. We give only the final results. If ρ_ν be the density of radiation which is absorbed, and if n_1 and n_2 be the concentration of atoms in the normal and excited states,

$$\frac{n_2}{n_1} = \frac{g_2}{g_1} \frac{\rho_\nu}{8\pi(h\nu^3/c^3) + \rho_\nu}. \quad (3)$$

When the light is derived from the temperature of the system we can put

$$\rho_\nu = 8\pi \frac{h\nu^3}{c^3} \frac{1}{e^{h\nu/kT} - 1},$$

and we have

$$\frac{n_2}{n_1} = \frac{g_2}{g_1} e^{-h\nu/kT}, \quad (3a)$$

as is usually obtained from direct application of Maxwell's law, and g_1, g_2 are the weights of the two states. If ρ_ν is very large

$$\frac{n_2}{n_1} = \frac{g_2}{g_1}, \quad (3b)$$

as we can expect from the definition of g_1 and g_2.

In the case of ionisation, let ν be the frequency of ionising radiation (supposed monochromatic). Then the law of ionisation is given by

$$\log \frac{x^2}{1-x^2} P = -\frac{(U - Nh\nu)}{2{\cdot}3RT} + \log\left(\frac{\rho_\nu}{8\pi(h\nu^3/c^3) + \rho_\nu}\right) + \frac{5}{2} \log T - 6{\cdot}5, \quad (4)$$

where $N = R/k$.

If

$$\rho_\nu = \frac{8\pi h\nu^3}{c^3} \frac{1}{e^{h\nu/kT} - 1},$$

i.e. radiation is due to the temperature of the system, (4) reduces to

$$\log \frac{x^2}{1-x^2} P = -\frac{U}{2{\cdot}3RT} + \frac{5}{2}\log T - 6{\cdot}5, \qquad (4a)$$

as is obtained directly from thermodynamical theories.

Equation (4) expresses equilibrium in a two-component system, equation (4*a*) in a one-component system.

Of course the ionising power is not limited to one single radiation, nor are all pulses of frequency $\nu > \nu_0$ (ν_0 = convergence frequency of the principal series) equally effective in causing ionisation. But these facts can be taken into consideration in the method used above.

MEGHNAD SAHA.
RAMANI KANTA SWE.

Allahabad, India,
January 21.

The Future of the Meteorological Office.

DR G C SIMPSON writes (NATURE, February 14) that he is sure I should not wish my remarks on the future of the Meteorological Office to be taken as more than my own personal opinion; but on the contrary I believe that my views are shared by a large number of meteorologists In 1920 the Royal Meteorological Society adopted a resolution regretting that the Meteorological Office had been placed under a Government department, created for another purpose, and urging that the Meteorological Committee should again have control, it was also pointed out that, when in the past changes had been made in the status of the Office, inquiries had been held On this occasion, since no report has been issued, we must conclude that the transfer of the Meteorological Office to the Air Ministry took place with no public inquiry, and to an outsider it appeared to have been made in a hurried and even arbitrary manner

The fear that the Meteorological Office may become a mere forecasting department of the Air Ministry, which is what I meant when I said that the future is uncertain, is not dispelled by Dr Simpson's reference to the "complicated meteorological service for aviation with its thirteen stations on aerodromes." The cares of hourly reports for aviators are not conducive to the development of scientific ideas, and a Government department which has such claims on the Meteorological Office may, under pressure for economy, neglect those aspects of meteorology not directly connected with immediate requirements. The pressure for economy may very likely prove stronger than an advisory committee. It is with misgiving that one notices the giving up of the radio research station at Smallshot Hill (now fortunately taken over by the Radio Research Board), and the transfer of upper air research from Benson, originally chosen for its suitability for *ballons-sondes*, to Kew, where it is in charge of an assistant-superintendent in place of a director of experiments. These researches, of great promise for the study of the atmosphere, were at the time of the change of no immediate utility to the Flying Service. When one considers the real additions to our knowledge of the atmosphere that have come from the freedom and seclusion of Pyrton Hill and Benson, it is almost painful to contemplate the rigorous conditions of a ministry as a nursery of research. Such changes inspire the fear that other researches not directly connected with flying may be dealt with in like manner.

If the Meteorological Office is to be only a forecasting office the chief work of which is for the Flying Service, I agree that it could not be in a better position than at present, but if it is still to be an instrument for the advance of the more purely scientific aspects of meteorology I am forced, despite the larger financial grant, to agree with the resolution of the Royal Meteorological Society. I regret that I am constrained to disagree with Dr. Simpson in this matter, the more so as I am indebted to him for continued help in many meteorological matters ever since he became Director. I sincerely hope that he will be right and that I shall be wrong; but that the future only can decide. In the matter of the present staff of the Meteorological Office I am in absolute agreement with Dr Simpson, and I used the following words in my address. "The staff of the Office is composed of men of the highest scientific calibre; probably never before in its history has it contained such a galaxy of talent"

C. J. P. CAVE.

Stoner Hill, Petersfield,
February 21.

The Michelson-Morley Experiment.

IN their scheme of their experiment, Michelson and Morley selected a single incident ray, showed how this would divide into a transmitted and a reflected moiety, traced out the path-lengths and found the difference δ Then, comparing the results in two orientations, they computed the difference $\delta_2 - \delta_1$, which they estimated at $l \times 2\beta^2 = (0{\cdot}00000002)l$ when $\beta = v/c = 10^{-4}$ and the semi-translucent mirror is set at $\theta = 45°$ They applied this computed difference of path-differences to predict a shift of bands in an interference-field; but they did not go into the question how the interference-field (which is undoubtedly observed) is produced.

The only way in which the scheme would work is to assume that the two virtual images of a point on the incident wave-front, formed by the two moieties from the single incident ray, themselves act as two virtual point-sources, capable of producing an interference-field. Also, there must be some definite observation point within the interference-field.

It does not seem to me to be reasonable to assume that the virtual images would act as luminous point-sources, because there would only be one ray to each virtual image, derived from the single incident ray.

I have worked out the precise positions of the final virtual images and the precise single reflected rays passing through these; all as definite functions of c, v and the constants of the apparatus including θ; and I have found a reasonable observation-point, to be reached by the observing eye in a time t.

Then, waiving objections to it for the moment, I have followed up the above implied assumption and calculated out the values of $(\delta_2 - \delta_1)$ for various values of v and various settings θ of the semi-translucent mirror. The results are remarkable and unexpected.

Let the apparatus be ideally constructed; true right angles, equal arms, etc. Let the semi-translucent mirror be set at an exact 45°; and let v be the full $c \times 10^{-4}$. Then (*a*) in both orientations the virtual images, assumed radiant, would be too close together (less than $\frac{1}{4}\lambda$ for yellow light) to produce any interference-field at all; and (*b*) $\delta_2 - \delta_1 = (0{\cdot}0000,0000,0003,0002)l$.

Therefore, on the single-ray scheme, when $\theta = 45°$ and $v = c \times 10^{-4}$, there ought to be no observable effect, not even an interference-field. With θ still at 45°, but $v > c \times 10^{-4}$, as v increases the virtual images are farther apart, and if they acted as virtual point-

sources, an interference-field would begin to be possible until, at a certain large value of v, the breadth of bands would correspond to that actually observed. The immediate neighbourhood of $\theta = 45°$ is a region of extraordinary sensitiveness, in which $(\delta_2 - \delta_1)$ passes twice through a zero value. Very minute changes in θ make very great changes in the value of $(\delta_2 - \delta_1)$.

The numerical data do not lend themselves to any general statement as to the value of v; but they point towards an actual value of v much greater than $c \times 10^{-4}$, however this may be accounted for. So far for the single-ray scheme, with the assumption required by it.

I prefer to deal not with a single incident ray but with an incident plane wave-front, and to study the kind of interference-field necessarily formed where the two reflected moiety-wave-fronts cross one another. Each virtual "image" of the previous working now appears as a point on a virtual plane wave-front, which is at right angles to the corresponding "single reflected ray" of the previous working. The working out is straightforward and unforced; and it again leads to remarkable and unexpected results.

Assuming θ to be an exact 45°, and $l = 1100$ cm. in an apparatus of ideal construction as above; then with yellow light ($\lambda = 0{\cdot}00005892$ cm.) we have in the first orientation a band-breadth of 11784 cm. if $v = c \times 10^{-4}$, 117·84 cm. if $v = c \times 10^{-3}$; 1·1784 cm if $v = c \times 10^{-2}$; and 0·011784 cm if $v = c \times 10^{-1}$

Assuming v to be $c \times 10^{-4}$, we similarly have band-breadths 0·0059 cm. if $\theta = 45° + 1024''$, 0·59 cm. if $\theta = 45° + 10''{\cdot}3$, 3928 cm. if $\theta = 45° + 0''{\cdot}001$, 11784 cm if $\theta = 45°$, ∞ if $\theta = 45° - 0''{\cdot}0005$, 11784 cm. if $\theta = 45° - 0''{\cdot}001$, 59·22 cm. if $\theta = 45° - 0''{\cdot}103$, 0·59 cm. if $\theta = 45° - 10''{\cdot}3$; 0·0059 cm. if $\theta = 45° - 1036''{\cdot}43$.

Working out and tabulating combinations of various θ's and v's and orientations we might hope, if we had an extraordinarily accurate knowledge of the lengths and angles involved, to be able to reach a conclusion as to the operative value of v from the band-breadths alone. The comparative shift of bands as between two orientations is not helpful in this respect; it depends upon a remainder in decimal places only, where we do not know either l or λ to a sufficient number of working figures. ALFRED DANIELL.

P.S.—By the courtesy of the Editor I have seen Sir Oliver Lodge's comment on the above letter. May I explain further that no bands would or ought to appear unless the instrument be in sufficiently rapid motion *when the semi-translucent mirror is set at an exact* $\theta = 45°$; if at any other angle, there will always be a certain amount of separation of the virtual images which may not be sufficient to produce an interference-field until aided by a sufficient velocity of movement (smaller than in the former case) producing a farther separation of the virtual images. The breadth of bands is a function of θ and v.

THE Michelson-Morley experiment looked for a shift of well-known interference-bands, about the formation of which there was no doubt or controversy. Ordinary wave theory explains the appearance of these bands with ease. Dr. Daniell, however, claims that no bands would or ought to appear unless the instrument was in motion, and that the width of the bands is itself an indication of the rapidity of motion, which is thereby proven to have a high value. This view is so hopelessly unorthodox that it is difficult to regard it with equanimity. Probably he is attending to one single precise ray—whatever that may be—and not to a small portion of a wave-front, with its inevitable slight obliquities. OLIVER LODGE.

The Theory of Hearing.

IN his letter in NATURE of February 14, p. 228, Prof. Scripture directs attention to the valuable work on the theory of hearing done at the New York research laboratories of the American Telephone and Telegraph Company. He refers to the papers of Fletcher, and of Wegel and Lane The results obtained by these experimenters, in his opinion, completely confute the resonance theory, though he considers that "The simple facts of the accelerated toothed wheel and of portamento speech . . ought to have been enough to convince any one."

All minds do not function alike, and those propositions which appear self-evident to one are by no means so to another. As an illustration of this truism one finds that Prof. Scripture, though he avails himself readily of the experimental results in question, rejects at once as unworthy of serious consideration the interpretation of those results given by the experimenters themselves To him it appears self-evident that the results are wholly inconsistent with the resonance theory, though the experimenters state their conclusions in terms of that modification of the resonance theory to which they give the name, the "dynamic theory."

The cochlea as conceived by Wegel and Lane is a highly damped resonating organ giving more or less localised responses to simple tones conveyed to it. The pitch of the tones heard is determined by the maximum points of the disturbances in the basilar membrane By the term "non-linear" response they imply (as seems to the writer) that the relation at various pitch levels between the intensity of the impulse and the loudness of the tone heard cannot be expressed graphically by a straight line From this they deduce the generation of combination tones and subjective harmonics in the cochlea Their theoretical deductions from the results of their experiments are perhaps vitiated by reason of their having left out of consideration the progressive graduation in tension of the basilar fibres by the spiral ligament. In any case there is nothing in them inconsistent with the resonance theory

Fletcher's results are indeed startling at first sight. The elimination of the fundamental and the first four upper partials from a clarinet tone produced no alteration of the pitch of the tone, the fundamental still appearing as the characteristic pitch He explains this as being due to the difference tone generated by the remaining partials To Prof. Scripture this explanation appears so surprising that he can only express his feelings by a note of exclamation To the writer the suggestion appears rational, and indeed inevitable. Are we to understand that Prof. Scripture does not believe in the existence of the subjective difference tone? Prof D. C Miller has analysed the clarinet tone He states that it may have twenty or more partials, with the seventh to the tenth predominating This latter group of partials are even stronger than the fundamental, and it is they which are chiefly concerned with giving the characteristic quality to the tone of the instrument. The difference tone of each successive pair of partials would, of course, have the same pitch as the fundamental. Even after the elimination of the five lowest partials, there would still remain fourteen pairs of generators to supply this difference tone. Possibly not all the partials would have sufficient intensity to act as generators, but the four predominating partials probably would. All these experimenters ascribe the generation of the difference tone to the cochlea, and not to the middle ear, as Helmholtz suggested. The writer has advocated the same view elsewhere, though not on the same grounds.

Prof. Scripture states that his deformation theory is capable of explaining these, and indeed all other phenomena of sound perception. Against this claim the writer feels impelled to enter a protest. So far as he is aware, Prof. Scripture has never formulated a theory of hearing. He has stated six "theses" (NATURE, April 26, 1924, p. 605), none of them new, and all of them highly disputable, on which he proposes to construct a theory. Now to the writer a "thesis" means a proposition stated for the purpose of proof or attempted proof. No such proof has been brought forward. To traverse these theses seriatim would be to review the controversies of the last sixty years. The writer is unable to recognise any material points of difference between the theory foreshadowed in the theses and the "pressure pattern" theories of Waller and Ewald, which he has discussed to the best of his ability elsewhere. He has already stated his objections in NATURE (May 31, 1924, p. 781) to some of the chief points of the theses, without eliciting any reply.

On the question of the nature of vowel sounds Prof. Scripture speaks as an authority, but one may be permitted to point out that he is not in agreement with other authorities. Prof. Miller states "The results of the work here described [on the analysis of vowel sounds] are in entire agreement with Helmholtz's theory, and are therefore out of harmony with Scripture's arguments."[1] Later, he speaks of the fundamental tone of the vowel being generated in the larynx.[2] When authorities differ, no single one of them is in a position to impose his own views as absolute.

In any case the simple piano experiments described by Helmholtz and Ellis, and referred to in my former letters (NATURE, May 31, p. 781, and July 19, 1924, p. 87), afford direct evidence that vowel sounds are capable of being analysed by resonators, and consequently weaken any indirect argument against the resonance theory which may be deduced from the supposed nature of vowel sounds.

G. WILKINSON

Sheffield.

Ecology of Moorland Plants.

IN an article upon this subject in NATURE of November 8, Prof. Priestley discusses the apparently xerophilous nature of the ericoid shoot, and concludes that a plant such as Calluna is better classed as a "xeromorphic mesophyte," which is "able to lose water like a mesophyte because in its natural habitat plenty of water is practically always available." This conclusion is preceded by a brief reference to the recent work of Stocker and Montfort showing that the water of moorland soils is not necessarily toxic to moorland plants, and does not, as Schimper suggested, diminish their effective water absorption. Prof. Priestley accepts their inference from these experimental results and states that the "physiological dryness" of a peaty soil is a "myth," and that therefore "there is not much left of the case for the xerophytic character of Calluna and the ericoid shoot."

I should like to point out that such experiments as those quoted are far from proving the non-xerophilous nature of the ericoid shoot, though they doubtless throw light on the very intriguing question of the water relations of ericoid shoots and leaves. It is true that structural features such as rolled leaves, thick cuticle, and protected stomata do not necessarily indicate xerophily; but the mere capacity for active transpiration during plentiful water absorption certainly does not prove the contrary.

The character common to all xerophytes properly so called is that of resistance to *drought* by any means, water storage, reduction of surface, etc. This has become increasingly clear from numerous observations and experiments of late years (cf. Holtermann, 1907, Fitting, 1911; Macdougall, 1912; Kamerling, 1914; Delf, 1915; the Maximows, 1924). The drought may arise either from atmospheric or from edaphic conditions, and may vary from a brief daily stress, as in the mangroves described by Holtermann (1907), to a prolonged water shortage, as in some typical Cactaceæ, but in either case the xerophyte can endure to lose water (often as much as about half its water content) without harm, whereas in mesophytic plants under the same conditions the leaves are wilted beyond recovery.

How far Calluna and other British Ericaceæ have this drought-resisting capacity has never, so far as I am aware, been tested, but the careful investigations of Thoday (1923) show beyond doubt that Passerina, a South African plant of similar "ericoid" habit and structure, possesses it in a marked degree. The water content of leafy shoots of Passerina gathered in the dry season varied from 25 per cent. to 45 per cent. (averaging about 30 per cent.) of the fresh weight; the water content of specimens taken in the rainy season being usually about 60 per cent. The shoots can thus lose quite half their normal water content without injury.

The case for the xerophily of the ericoid leaves of the British Ericaceæ, though unproven, is thus still highly probable, whatever be the absorptive capacity of the root system when *sufficient* water is available. It is, however, scarcely necessary to point out that, when water is present in the soil, it is not *necessarily* "available" to the plant in the physiological sense of the word, apart from any question of toxicity. "Availability" is estimated as that fraction of the water content of the soil at saturation which can be withdrawn by a well-established rooted plant before wilting can be detected. The wilting point depends upon the constitution of the plant as well as upon other factors. It was shown by Crump in 1911 that when Calluna grows on acidic peat only four-fifths of the soil water is available. That is, if we call the water content of the saturated soil, reckoned per unit of dry weight, 100, signs of wilting will occur in Calluna whenever the remaining soil water has become reduced to 20. In *Erica tetralix* growing in the same soil, the signs of wilting occur when as much as 30 per cent. remains. Such plants may thus have apparently "plenty" of water but actually a water deficit (especially if transpiration is active at the time), which is exactly what would be expected from their structure. It is not known how this condition of incipient wilting in Calluna reacts on the transpiration rate, but measurements of the water content of the plant as it occurs in Nature would probably reveal a much wider variation than is tolerated by plants of a typical mesophytic habit.

Further experimental work is obviously needed before any more definite conclusions are drawn as to the xerophily of the Ericaceæ. Whether their peculiar structure arises as "a natural developmental consequence of the characteristic metabolism of a root system growing in a soil that lacks sufficient aeration," as Prof. Priestley suggests, is an entirely different question which is independent of the possible significance of the final differentiation attained.

E. M. DELF.

Westfield College
(University of London).

[1] "The Science of Musical Sounds," D. C. Miller, p. 217.
[2] *Ibid.* p. 242.

APART from the fact that the conclusion that Calluna is a "xeromorphic mesophyte" should be attributed to Stocker, there is nothing in Dr. Delf's remarks with which I find myself in disagreement, except with regard to their relevance to the point at issue.

Certain features of the structure of moorland plants, inrolled leaves, sunk stomata, thick cuticle, etc., have been explained teleologically as designed to reduce transpiration. Stocker and Montfort show experimentally that the plants transpire very freely in spite of these features. Dr. Delf does not help the teleological argument by pointing out that, even though they lose water freely, the plants may still thrive because of other xerophytic characteristics Nor are Crump's results relevant to the problem of moorland plants growing in regions of excessive rainfall. The contemplation of these same "xerophytic" structural features in such swampy moorland regions had led to the suggestion that the water might not be "physiologically" available, but Montfort's experimental results show that plants absorb it freely.

It interested me very much to learn, from the presidential address of Prof. F. E. Weiss to the Ecological Society on January 10 last, that these same structural features provide a similar puzzle to the palæobotanist. On one hand, it is argued from such leaf characters that the coal measure forests grew under xerophytic conditions; on the other, from root systems and other features, it is argued that they grew in vast swamps. J. H. PRIESTLEY.

The Need for a Universal Language.

NOBODY, not even Prof Kent or Mr Heron-Allen, really wants Latin as a universal language. Latin is dead; its natural development has ceased and could not possibly meet the growing needs of international thought. Every one recognises that the classical tongue, if it is to satisfy modern needs, must have its grammar simplified and its vocabulary, especially of abstract terms, enlarged. But the features which are to be changed are those which give Latin its peculiar savour and the educational value that some would claim for it. "Modernised Latin" is not Latin at all; it is a hybrid jargon as artificial as Volapuk or Esperanto, as devoid of literary tradition, as incapable of artistic expression, as subject to national and individual vagaries. Of this last defect, of which he accuses Esperanto, Mr. Allen gives a crushing example. Few but English speakers would understand *statio* for railway-station; few but blundering schoolboys would use *quae* as a substantive for *quis*.

The Latinists are crying for the moon. They want as a medium for international communication a "natural" language with at least the possibility of literature. The thing is impossible. To fulfil its object the medium must mean the same thing to all men, however diverse their mentality or experience. The allusiveness that makes literature possible is the fruit of a common life and history; it is the fruit of that nationalist sentiment which it is one of the main purposes of the language to remove. Universal intelligibility and artistic expressiveness can never be combined in a single medium; for art is the trick of meaning rather more than you say. I hope nobody will reply that, if a universal language must always be divorced from literature, we are better without it. That was the fallacy of Ruskin and the cause of most of the sordidness of the Victorian age. An art which seeks to limit utility is doomed; and if literature is set in opposition to scientifically impersonal expression, literature will wither.

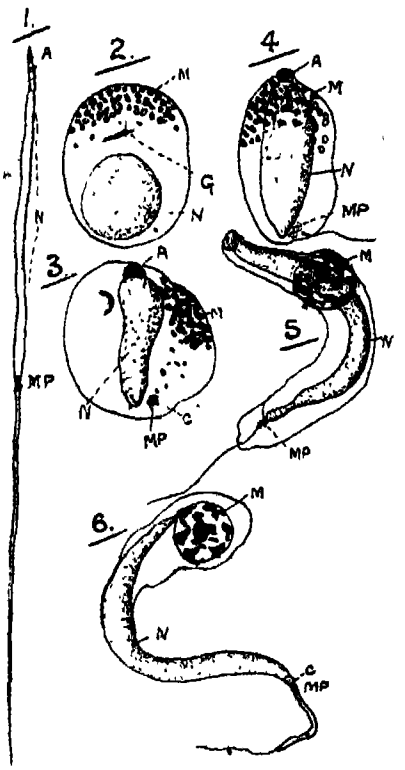
Of course, the view is tenable that modernised "Latin," confessedly artificial and developed from the language of the Romans by some conventional scheme, would be better than its rivals even according to their standards. But it is much more important to have some international language than to have the best conceivable. Esperanto is within the bounds of practical possibility; it has made definite progress; it is supported by an enthusiastic organisation; it is actually being broadcast. For the great mass of the unlearned, anything called Latin is eternally damned by its associations. To some it suggests examinations and school punishments, to others pedantry and obscurantism. It is not a practical possibility, and those who press its claims are merely hampering the cause they profess to serve

NORMAN R. CAMPBELL.

Spermatogenesis of Peripatus.

THIRTEEN years ago Montgomery, an American cytologist, published a paper in the *Biological Bulletin*, claiming that in Peripatus there was complete rejection of the mitochondria during spermateleosis. This work has been widely quoted as strong evidence against the Meves' mitochondrial idioplasm theory; but Montgomery's investigation has never since been confirmed or denied

Owing to the good offices of Prof. Gilchrist, of Cape Town, South Africa, and of Canon Forrester, Chaplain of Trinity College, Dublin, six small specimens of the Cape Peripatus arrived alive in Dublin, and I was able to procure some fairly good sections showing spermatogenesis.



At first I believed that Montgomery was correct, but latterly I have modified my views. In Fig 1, it will be seen that the middle-piece (MP) is very small — probably proportionately smaller than that of any other animal; consequently the problem of its manner of formation is not easy to solve. Figs. 2, 3, 4, and 5 show the mitochondria at M, finally forming a ball, as claimed by Montgomery. This ball is certainly extruded (Fig. 6) as explained by Montgomery, but if one examines a large number of well fixed cells at the stages depicted in Figs. 3, 4, and 5, one will nearly always find a number of fine granules (MP) which eventually form the middle-piece of the tail. I think that these granules are of the nature of mitochondria, because their reactions are similar, and I have got the impression that the middle-piece of the Peripatus sperm is formed from a few of the finer

mitochondria, whereas the main bulk of the coarse granules are rejected. In dealing with such a small cell, and when such small quantities of material are involved, it is not possible to be more explicit. It can be said with certainty that the middle-piece is formed from definite granules which do not appear to be secreted *per se* in the ground cytoplasm.

J. BRONTË GATENBY.

Trinity College, Dublin,
February 10.

Intermetallic Reactions in a Lead-base Bearing Metal.

AN investigation into the influence of pouring temperatures and mould temperatures on the microstructure of a lead-base bearing metal of the following percentage composition (lead, 82·5, antimony, 11·0, tin, 5·5; copper, 1·0) has shown that it is possible for the antimony to unite either with the tin, to form cubes of the compound SnSb, or with the copper, to form needles of the compound Cu_2Sb (Regulus of Venus). Three different pouring temperatures have been employed in this investigation—500° C., 400° C. and 300° C. It has been found that chill castings poured at the higher temperatures—500° C. and 400° C.—contain but slight traces of the tin-antimony compound, whereas chill castings poured at 300° C. contain but few of the purple needles of the copper-antimony compound. If a chill casting containing the tin-antimony compound (that is, one poured originally at 300° C.) be melted and poured at 500° C., the tin-antimony cubes are almost completely replaced by copper-antimony needles. If, however, a chill casting containing the copper-antimony compound (that is, one poured originally at 500° C.) be melted and poured immediately on arrival at 300° C., the copper-antimony needles persist. That the copper-antimony needles may, however, be replaced by tin-antimony cubes is shown by the fact that when a sample of the alloy is heated to 500° C. and allowed to cool slowly to 300° C. before pouring, cubes of tin-antimony compound are found in the chill casting produced.

It is believed that the above observations are new. I should be glad, however, to hear if reactions of a similar nature have been observed in alloys of this or other systems.

O. W. ELLIS

University of Toronto,
Toronto, Canada,
February 9.

The Auroral Green Line.

(By Cable.)

DR. SHRUM and I have observed in the spectrum of a mixture of air and helium, with the latter in excess, a line at 5577·35±0·15. Mixtures of oxygen and helium give the line enhanced approximately to one-half the intensity of each of the yellow lines of helium.

A long discharge tube was used, surrounded over part of its length with liquid air, and the best results were obtained with a pressure of about five millimetres of mercury. The line was not observable in the spectrum of purified oxygen, hydrogen, nitrogen, or helium. No mixtures of any two of these gases other than oxygen and helium gave this spectral line.

The line is narrow, very sharp, and well defined, and these characteristics, together with its wave-length and the conditions under which it is observable, point to its identity with the auroral green line.

J. C. MCLENNAN.

University of Toronto,
March 10.

Demonstration of the Heating Effect of a Magnetic Field.

To demonstrate the heating effect of a magnetic field, Tyndall revolved between the poles of an electro-magnet a copper-pipe filled with an easy melting fuse: the heat disengaged in it by eddy-currents melts the fuse and the liquid metal is sprayed out in visible globules. To render the heating effect of eddy-currents even more conspicuous, it occurred to me to make the revolving body to glow, and I adopted, after some trials, the following arrangement.

I used as a *rotor* (*Fig. 1*) a copper-ball fixed to a

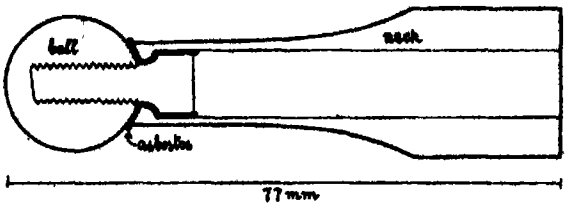


FIG. 1.

copper-neck, and insulated from it by asbestos. The rotor was fixed by the neck to the shaft of an electro-motor—the neck being sufficiently long to allow the ball to be placed in the magnetic field between the poles of the electro-magnet.

Revolving a ball 22 mm. in diameter in a field of $5·7 \times 10^3$ C.G.S. at a rate of 5½ thousand revolutions per minute, the ball begins to glow in a dark room after 1½ minutes, and in a fairly dark room after 1½ minutes.

Omitting the asbestos insulation between the ball and the neck delays the beginning of the glow by about a minute.

HARALD PERLITZ.

Fyysika Instituut, Tartu, Estonia,
February 3.

The Propagation of Radio Waves over the Earth.

THE modified form of the ionic deflexion theory of wave propagation, discussed by Messrs. Nichols and Schelling (NATURE, March 7, vol. 115, p. 334), appears to have been suggested in England and the United States almost simultaneously. That the effect of the earth's magnetic field had to be taken into account in calculating the phase-velocity was pointed out in a paper on "Geophysical Influences on the Transmission of Wireless Waves" read at a joint discussion of the Physical Society of London and the Royal Meteorological Society in November 1924 and already published. The formula for the phase-velocity for transmission along the earth's magnetic field and the calculation of the critical frequencies were there given, and some consequences of these effects have been discussed in a paper communicated to the Cambridge Philosophical Society. Since the earth's magnetic field is strong enough to affect the phase-velocity to a sufficient extent, all the rotatory and double refraction effects familiar in physical optics are appreciable. But probably the most interesting possibility is that the reciprocity relation between two wireless stations may not hold, for the extra forces on the moving electrons due to the earth's magnetic field are, to a certain extent, independent of the direction of propagation of the waves and thus produce relatively different effects for the two directions of transmission.

E. V. APPLETON.

Wheatstone Laboratory,
King's College,
London, March 7.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

II. HENRY WILDE (1833–1919).

HENRY WILDE would have taken a very prominent place among the scientific men of his time had his exceptional abilities not been handicapped by an obstinate and querulous disposition. He had imagination, ingenuity, and considerable experimental skill, but on the other hand he was possessed by vanity, pugnacity, and contempt for anybody else's opinion. In his scientific work he had a good sense of discrimination between the essential and the accidental, but in his personal relations with others, trivial grievances were magnified into serious injuries. Once he complained to the Vice-Chancellor of the University of Manchester that one of his clerks had insulted him. After an expression of regret and on a request for details, it appeared that the clerk, by an oversight, had omitted to put "F.R.S." after his name on a letter.

The threat of legal proceedings was Wilde's favourite method of controversy, and he was reported to have offered his solicitors twice the usual fees on condition that they should never dissuade him from taking legal action I once asked him why he was so fond of going to law. He replied that it was out of gratitude; and explained that early in his career, while he was the defendant in a law suit, the judge put a question to him which he could not answer, but when he was thinking about the matter on his way home, he was led to the train of thought which resulted in the construction of the first dynamo-electric machine. One would like to know the name of the judge and the exact nature of the question. The law suit referred to was probably that brought by the Universal Private Telegraph Company against Wilde for infringement of patent; the case was decided in his favour.

During the greater part of his scientific life, Wilde was afflicted by a sense of injury, due to what he looked upon as an insufficient recognition of his claim to have invented the dynamo-electric machine. This culminated ultimately in an unfortunate law suit which Wilde brought against Silvanus P. Thompson, who in his well-known treatise had stated that Werner Siemens, in a communication read before the Berlin Academy of Sciences on July 17, 1868, first used the expression to designate all appliances which now pass under the collective name of "Dynamos." Wilde, on the other hand, claimed that the term was first applied to his own machine by Brooke. Thompson was certainly inaccurate in his statement. In the only sentence in which the expression "dynamo-electric" was used by Siemens, it denotes what we now should call "motors." It is a pleasure to add that while Silvanus Thompson won his case both in the first instance and on appeal, he afterwards revised the historical account given in his treatise, recognising Wilde's work in a manner that is not only adequate but even generous.

Disregarding questions of nomenclature, there is no doubt that Wilde's paper, communicated to the Royal Society by Faraday in 1866, was the first important step in the production of electric currents on a scale which opened out the possibility of great industrial applications. Stokes more than once referred, in conversation, to the great impression created at the meeting of the Royal Society when an iron wire, fifteen inches long and one-quarter of an inch in diameter, was raised to white heat and melted.

Mr Haldane Gee, of the University of Manchester, in his obituary notice of Henry Wilde (Memoirs of the Manchester Lit. and Phil. Soc. vol 43, No. 5), which contains much interesting information, tells us that Wilde was the son of a working man and was apprenticed to an engineering firm at the age of sixteen. Whatever the social status of his parents may have been, his early surroundings must have been refined and cultured. Though self-taught, his language and style of writing were those of a highly educated man The extent of his knowledge of the history of science and philosophy, as well as his acquaintance with general literature, were remarkable.

Wilde's contributions to technical science were both numerous and important, but in his later years practical applications interested him mainly in a financial sense. It will be remembered that when the general public was brought to realise, almost suddenly, that the electric lighting of houses would come into general use, a panic set in among the shareholders of gas companies. Wilde, with clear foresight, chose the moment when the shares were at their lowest, sold his electric works and invested the proceeds in the General Gas and Coke Company. This, together with the royalties he received, secured him a substantial income, and he could thenceforward devote himself to unremunerative work.

Apart from his papers on terrestrial magnetism, to which he devoted much time, and excepting the subject of aviation, Wilde concentrated his attention in later years mainly on questions of a fundamental character. In these, his self-trained mind felt itself free to disregard all authority and to be guided only by his own instincts. Facts were, to him, simply illustrations to be accepted or rejected according as they did or did not fit in with his own views. His firm belief in the evidence of an intelligent design in Nature, which was the basis of his religious and scientific faith, convinced him of the necessary simplicity not only of fundamental laws but also of fundamental facts. Hence his absolute rejection of anything but integer numbers to express physical or chemical relationships. If chemists gave fractional figures for their atomic weights, their measurements, in Wilde's judgment, were necessarily wrong, and if simplicity rules the world, atomic weights were likely to follow the same order as planetary distances, with regard to which he gave unqualified assent to Bode's Law.

For the subject of the annual "Wilde Lecture" of the Manchester Literary and Philosophical Society, which he had endowed and himself delivered in 1902, Wilde selected the old-standing controversy between the followers of Newton and Leibnitz on the measurement of force. To him force meant energy, and he naturally put himself on the side of Leibnitz. The lecture, to which he gave the title, "On the Evolution

[1] Continued from p. 343.

of the Mental Faculties in Relation to some Fundamental Principles of Motion," was a great effort of special pleading, and contains references to passages in the writings of Bacon, Locke, Halley, Copernicus, De Morgan, Descartes, Newton, MacLaurin, Schopenhauer, and more modern writers. As an example of Wilde's style, the second paragraph of the lecture may be quoted:

> "It will be universally allowed that if one of the Simiinæ could be taught to enunciate a false proposition, *e.g.*, that space is four dimensional, or that the twentieth century commenced on January 1st, 1900, such a creature would be much more interesting to naturalists, and be more highly valued by collectors, than any of its inarticulate companions of the forest."

Wilde had a grim sense of humour. When some act of the University of Manchester displeased him, one could feel pretty sure that he would give effect to his displeasure by a benefaction to some other scientific institution, generally at Oxford or Paris. He once asked the treasurer and an important member of the council of Owens College to call on him on an important matter. Hopes of a substantial endowment ran high, but they had to hide their disappointment when they found that their presence was only wanted to witness a signature or to assist at some similar trivial function. Wilde's residence stood near the top of a steep lane on Alderley Edge. When bicycling came into fashion several accidents occurred at that point, and Wilde fixed on the usual danger-post a board which carried, beneath the drawing of a skull and cross bones, the legend: "A stretcher may be obtained at the Hurst Cottage below when required." A picture of the post, in its surroundings and with two cyclists inspecting it, appeared in the *Daily Graphic* on September 11, 1900.

Wilde received blows as cheerfully as he dealt them out. It was once my disagreeable task to propose a vote of censure on him while he was sitting in the presidential chair at the Literary and Philosophical Society of Manchester. He had written a letter making unjustifiable accusations against the treasurer of the Society, and some action became necessary. I first gave him an opportunity of withdrawing the letter, but he refused, and when I had made my speech and it came to the vote, Wilde simply said, "I withdraw the letter," and went on with the business of the meeting. "I have had many pinpricks from you, but you have also done me some kind actions," was all the reference he made to the incident after the meeting. Our friendship was never affected by such incidents. He might, at the end of a long discussion during one of his frequent visits to my laboratory, tell me that I was not fit to be a university professor, and a day or two later make amends by sending me a basket of beautiful hot-house grapes.

Wilde's fondness for litigation has already been mentioned. One might almost say that he looked upon it as a form of recreation. I have before me copies of lawyer's letters filling nearly twenty pages, all containing threats of legal action against the Manchester Literary and Philosophical Society, which he truly loved and of which he was a munificent benefactor. It is not necessary to enter into details with regard to them, but his dispute with the Royal Society of Arts deserves to be placed on record, and as an introduction to it I must refer to a previous incident.

Wilde had given a sum of money to the Manchester Society to enable it to award from time to time a gold medal for meritorious work. The Society considered it appropriate to offer the first medal to the donor. Knowing his sensitiveness with regard to the discovery of the dynamo machines, they laid great stress on it in formulating the reasons for the award. Wilde was up in arms: "Your Society," he told the Council, "is a body for the prosecution of pure science. You have nothing to do with technical applications." He refused to accept the medal unless the Council modified their reasons for the award, emphasising his discoveries in pure science. The Council did not see its way to accept Wilde's own formula and the matter proceeded no further. In the following year (1900), the Council of the Royal Society of Arts decided to confer the Albert Medal on Wilde "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small." Wilde again raised objections. The Royal Society of Arts, unlike the Manchester Society, was concerned with industrial applications, while the wording of their award laid stress on a principle rather than on an application. This aroused his suspicion that his claim to the invention of the dynamo and its application to industrial processes was not sufficiently recognised by the Society. In his reply to the letter conveying the award of the medal, Wilde wrote:

> "Considering that the principal object of the Society is to give encouragement to Arts, Manufactures, and Commerce, which object is prominently set forth in most of the awards of the Albert Medal hitherto made, the absence of all reference to the industrial applications of my discoveries and inventions in the terms of the award is a notable omission, and, if unrectified, will effectually preclude me from accepting the honour for which I have been designated by the Council."

Three days later Wilde wrote again to suggest a wording which he would consider satisfactory. In the meantime the proposed conferment of the medal in the original terms had been published in the daily press; this resulted in a lawyer's letter, and the issue of a writ to restrain the Society of Arts from announcing the award in their own journal before some agreement had been arrived at as to the wording. The Society then altered the wording. It added a sentence referring to Wilde's application of his machine to search-lights and the electro-deposition of metals; and with regard to the dynamo machine, it added that the principle which formed the basis of Wilde's work is "now used in all dynamo machines." This was a fair and adequate statement, but it displeased Wilde more than ever. I think, however—and I saw much of him at that time—that he was more amused than vexed when the Society sent him the medal by post instead of following their usual practice of presenting it at their annual meeting under the presidency of the Prince of Wales.

The incident ended with a letter addressed by Wilde to the Institution of Electrical Engineers, in which, after declaring his dissatisfaction with the terms under

which the medal had been bestowed upon him by the Royal Society of Arts, he proceeds:

"Nevertheless, the action of the Society has invested the Albert Medal of 1900 with a considerable degree of historical interest, and, in response to the recent invitation of the Council of the Institution for gifts of such objects to form a permanent Museum, I enclose herewith the Medal as a contribution to the collection."

The whole correspondence was afterwards published and freely circulated by Wilde.

One of Wilde's peculiarities was his strong objection to have his photograph taken, which was a pity, because he really had a fine and expressive face. "I want to be remembered by my works and not by my physiognomy," he often told me. He added that on one occasion he gave way to the wishes of his wife, but having repented he had the plate destroyed. A copy, however, seems to have been kept by the photographer and was reproduced in his obituary notice. I cannot help regretting this disregard of his wishes

It remains to mention his extensive benefactions. He gave altogether 10,000*l.* to the Manchester Literary and Philosophical Society and 5500*l.* to the Académie des Sciences of Paris. His endowments, during his life, of scholarships and readerships at Oxford amounted to 3000*l.*, and a contribution of 1500*l* to the Benevolent Fund of the Institution of Electrical Engineers raised the total of these gifts to 30,000*l* Yet he died a comparatively poor man The residuary estate, which was bequeathed to the University of Oxford, after deducting some minor legacies, only amounted to 10,000*l.*

I am afraid that this account dwells a good deal on Wilde's pugnacious peculiarities, but in spite of many acute differences of opinion, I had a very high regard for his straightforward character and attainments. We always remained friends.

The Phylogenetic Classification of Flowering Plants.[1]

By JOHN PARKIN.

THOUGH "the abominable mystery," as Darwin called the problem of the origin of Flowering Plants, is by no means solved, there has been before the botanical world for some years a theory of their origin which is consonant with the derivation of all forms of existing flowers from the Ranalean type. Through Wieland's brilliant elucidation of the structure of the fossil Bennettitean fructification at the beginning of this century, botanists became acquainted for the first time with an unexpected bisexual seed-bearing cone, in which the two kinds of sporophylls bore the same relative position to one another on the axis as they (the stamens and carpels) *invariably* do in the angiospermous hermaphrodite flower; and further, such a cone was subtended by a number of bracts resembling a perianth. The temptation naturally was great to suggest a real bond of affinity between the Flowering Plants and these Cycadean-like Mesozoic plants, the Bennettitales (Cycadeoideæ). A theory was worked out to this effect. Though the peculiar nature of the female part of the cone precludes the direct origin of the Angiosperms from the Bennettitales, the view was put forward that the two groups had diverged from common ancestors with a generalised type of flower-like cone—the *anthostrobilus*, as it was called. These ancestors, it was thought, probably arose from the seed-ferns (Pteridosperms). It was further conjectured that the Angiosperms owed their being to the substitution of insect-pollination (entomophily) for wind-pollination (anemophily), and it has even been hazarded later that this type of cone, the anthostrobilus, may have been evolved in response to insect-visitation. The theory also provided a resting-place for that small puzzling group of Gymnosperms, the Gnetales, and accounts for the peculiar male (morphologically hermaphrodite) "flower" of Welwitschia — the stumbling-block to those botanists who endeavour to derive the Gnetales from the Conifers, a group characterised as a whole by possessing unisexual cones.

The whole speculation, which has rightly or wrongly been termed the "strobilus theory of angiospermous descent," still awaits confirmation or refutation. It has with some botanists lost favour on general grounds. The recent discoveries of palæobotany show that many of the main groups of vascular land plants can be traced right back to Devonian times as independent lines, and Dr. A. H. Church in a recent stimulating memoir has speculated as to the possibility of these main phyla having been even differentiated in the sea independently from one another. Thus it is just possible that the Angiosperms may represent such an independent line, originating from a distinct group of Algæ. Their resemblance then to the Bennettitales would become merely an interesting parallelism. This then may be said to be the chief criticism that can as yet be levelled against the strobilus theory. Dr. Scott, in his latest edition of his "Studies in Fossil Botany," sums up in favour of the theory.[2] If the Angiosperms throughout the ages have been independent of any other vascular group, one wonders why obvious traces of them have never come to light in the Palæozoic rocks. It is difficult to believe that they can, as it were, have stepped out of the sea, fully differentiated, in late Mesozoic times. One of the astonishing facts of palæobotany has been the sudden appearance of Flowering Plants in late Cretaceous times. Dicotyledonous stems are now known, however, from lower Cretaceous rocks, and recently Mr. Hamshaw Thomas has brought to light some remarkable fossil fruits (the Caytoniales), resembling those of Angiosperms, from the middle Jurassic. Possibly then ere long some fresh light may be thrown on the problem.

It is important to recognise that the classification of Angiosperms based on the Ranalean families does not stand or fall with the Bennettitalean theory. If the latter be disproved, the former is only affected to the extent that it has no fossil group upon which to fall back. All modifications of the flower can still as before be derived from a magnolia-like one. The Bennettitalean theory has helped to focus the attention

[1] Continued from p. 342.

[2] 3rd edit. vol. 2, London, 1923, pp 427-430

of botanists on the Ranales. Once they have grasped the possibilities of making this group of families a basis upon which to found a new system of classification, they will not be likely to return to the Englerian view of the primitive flower, should the theory have eventually to be discarded. In this way it will have served a useful purpose.

In recent times certain botanists, notably Bessey of America and Hallier of Holland, have endeavoured to supersede Engler's classification by introducing systems of their own based on the Ranalean families. Hallier was perhaps too changeable and prolix to attract the attention he deserved. Bessey was more thorough and logical. The writings of both suggest, however, that their attempts at new systems were more the outcome of book-work than of the actual examination of the living or dried specimens. It is otherwise with Hutchinson. He has not only at hand an unrivalled collection of plants, but also has behind him some twenty years' experience of comparative work in this line. In his first "Contribution" he sets forth his principles,[3] which are essentially those of Bessey, and, we surmise, they will be generally acceptable to those botanists who have ceased to believe in the primitive character of the amentiferous flower. He points out that the evolution of the flower among existing Angiosperms has taken, broadly speaking, either an upwards or downwards course. This in terms of function may be interpreted as either greater adaptation for insect-pollination or a change-over from entomophily to anemophily: and in terms of structure as either great modification and advancement in the shape of the corolla or the complete loss of this organ as no longer required for insect-attraction.

These two evolutionary changes may be considered to have been continually in action in the past and to be still in operation The older the petalous (entomophilous) group, the more apetalous (wind-pollinated) forms will it have given off This is exemplified by the fact that the Apetalæ (in the taxonomic sense) have probably been derived as a whole from the Polypetalæ (petals free), a group generally considered earlier and more primitive than the Sympetalæ (petals united). These latter, of mixed polypetalous ancestry and in most cases highly specialised for insect-visitors, present few anemophilous forms. The plantains (Plantaginaceæ) and our native ash (*Fraxinus excelsior*) alone come to one's mind. In the former the corolla has not actually disappeared, though scarcely functional. The latter has naked and often unisexual flowers, though certain species of this genus and the rest of the family (Oleaceæ) have hermaphrodite flowers with a corolla. Perhaps Englerians would have held the flower of the ash as primitive if it had stood alone. As it is, no botanist doubts but that this tree has had petal-bearing entomophilous ancestors.

The paucity of apetalous derivatives from the Sympetalæ may be considered to be due to the shortness of geological time since these forms appeared. At the same time it is well to bear in mind the possibility that the more highly specialised for entomophily a flower becomes, the more difficult it may be for it to change over to anemophily. Hutchinson uses these ideas of progressive and retrogressive evolution as applied to the flower in his proposed scheme for the rearrangement of the earlier dicotyledonous families (Archichlamydeæ). So far as possible, in any circle of affinity, after fixing on the basal group, he first treats of the families showing corolla-advancement, *i.e.* those increasingly adapted for entomophily; and then the families showing corolla-reduction, *i.e.* the degraded forms which through force of circumstances have had to take to anemophily.

A restrictive attitude is adopted by Hutchinson in respect to the value given to the various grades of classification, such as order,[4] family, and genus. The groups thereby become more natural and less unwieldy. An example will illustrate his mode of procedure. Engler's old cohort, Ranales, comprising about 15 families, is split into five orders—the Magnoliales, Anonales, Laurales, Ranales, and Berberidales. His Magnoliales embrace practically the genera contained in the old family, the Magnoliaceæ. This he breaks up into three families—the Magnoliaceæ, Winteraceæ[5] (Drimys and its associates), and Schizandraceæ. The Magnoliaceæ now becomes a very natural family, composed of the genera Magnolia, Michelia and their close allies, together with the Tulip-tree (Liriodendron). The Ranales in the restricted sense contain the Ranunculaceæ (unaltered in composition, but its taxonomy improved upon that occurring in the "Pflanzenfamilien"), the Nymphæaceæ and the Cabombaceæ, formerly a tribe of the foregoing but now raised to family rank.

In some ways we regret the use of Ranales in this restricted sense, though it is in accordance with taxonomic rules. This term and its adjectival form, Ranalean, have been employed in recent times in the wide sense, and especially with respect to the Magnolian flower, hence confusion may be apt to arise in the near future. This, of course, can be avoided by strictly defining one's terms. A new embracing term is now wanted for the families composing, say, the old Ranales together with the Dilleniaceæ. Might not also a substitute be found for the clumsy term, Archichlamydeæ—one in keeping with Sympetalæ, which Hutchinson apparently intends to use instead of Metachlamydeæ? The revival of the Choripetalæ of Eichler is a possible suggestion.

The view that the tree preceded the herb is one that has made headway in recent years. The reverse was perhaps vaguely held last century. Hutchinson makes full use of this new idea, though at the same time prepared to recognise that here and there the opposite may have taken place, namely, herbs giving rise to woody forms. He thinks, for example, that both Clematis and Berberis have had a herbaceous origin. This is distinctly interesting to plant anatomists. It may be expected that the wood of shrubs and trees evolved from herbs will show structural features distinct from the wood of trees which have come from ancestors primitively arboreal in habit. In his proposed rearrangement of the Archichlamydeæ he shows graphically by means of a phylogenetic tree[6] the possibility of

[3] *Kew Bulletin*, 1923, p. 73.

[4] To the older field botanists familiar with the term, *natural order*, now superseded by that of *family*, the use of *order* in this wider sense may be confusing. It was adopted in place of *cohort* by the International Botanical Congress of Vienna, 1905. Presumably there were strong reasons for this change, but they are not apparent to the present writer.

[5] *Kew Bulletin*, 1921, p. 165.

[6] *Kew Bulletin*, 1924, p. 128.

deriving this assemblage of families as two distinct branches—one from the tree Magnoliales and the other from the herbaceous Ranales. Each branch in its ramifications is depicted as giving its quota to the "Apetalæ," the tree-line supplying chiefly the Amentiferæ, and the herb-line such alliances as the peppers, docks, and chenopods. In one case the arborescent habit continues dominant, though herbs eventually arise in the highest forms, *e.g.* in the Papilionaceæ; in the other case herbs prevail, though shrubs and trees occasionally make their appearance. This novel and suggestive idea requires thorough sifting to see how far it may be considered sound. In this connexion, we may here point to his treatment of the family, Saxifragaceæ, as defined in the "Genera Plantarum" and "Pflanzenfamilien." Most will admit that this family, as at present constituted, is cumbersome and unnatural. Hutchinson brings his tree-herb speculation to bear upon it and cleaves it in two. The herbaceous Saxifrages and their allies are placed along with the Crassulaceæ in the order Saxifragales, derived directly from the Ranales (in the strict sense); while the remainder of the old family—the bulk of it, in fact—is split into the Escalloniaceæ, Grossulariaceæ, and Hydrangeaceæ, and as such compose part of his new order, the Cunoniales, derived directly from the arborescent Dilleniales. In consequence, the old family is separated into two sections placed far apart. In this connexion one would like to know how he views the hitherto supposed relationship between Spiræa and Astilbe. If he still recognises it, then no provision appears to be made for it in his scheme. He derives the Rosaceæ, and presumably the genus Spiræa, from the woody Dilleniales; whereas the Saxifragaceæ, as he now limits the family, to which Astilbe should naturally belong, are obtained from the herbaceous Ranales. He partly saves himself in a footnote [1] as follows: "It is probable that some herbaceous *Rosaceæ* have not had a common origin with their ligneous associates." But among the Spiræas are many ligneous forms. These will still require explaining.

In conclusion, it may be thought that the introduction of a new classification of Flowering Plants is a task of too great importance to be entrusted to a single individual. Some may hold it to be a matter for a body of experts. Taxonomy, however, in the past has not progressed in this way. Systems have largely been the result of individual effort. Some have become authoritative, others have not. A single mind tends to keep throughout a consistent value for the various grades of classification. The whole effort will show on completion a symmetry and balance which it otherwise would not possess. This is far from saying that a new system should not be subjected to searching criticism while it is yet in the process of elaboration.

[1] *Kew Bulletin*, 1924, p. 117.

Obituary.

RIGHT HON. SIR CLIFFORD ALLBUTT, K.C.B., F.R.S.

THE sudden and quite unexpected death, after a few minutes' distress, early on the morning of February 22, of Sir Clifford Allbutt, Regius professor of physic at Cambridge since 1892, robs British medicine of its acknowledged leader, who from his scholarly accomplishments recalls Samuel Johnson's description of William Heberden the elder (1710-1801) as "Ultimus Romanorum, the last of the learned physicians." He was indeed remarkable for his wide knowledge not only of modern but of ancient medicine, and for the broad horizon of his conception of the relations of medicine and how its future course should be directed. Thus he was ever insistent on the importance of a sound general educational basis on which medical studies should be engrafted, and he held strongly that universities should provide a liberal education and not lay themselves out for the more utilitarian qualification for the practice of any art or trade, and should not compete with hospital schools. His high standard was shown in a work—the result of many years' research—on "Greek Medicine in Rome" (1921). Since 1888 he had advocated the necessity for the study of comparative medicine and pathology, and happily he lived to see his own University start an Institute for this branch of research, and appropriately he was the first president of the Section of Comparative Medicine at the Royal Society of Medicine.

The wisdom of Allbutt's selection as Regius professor of physic in 1892, and of the departure from the existing custom of appointing a resident physician, has been signally justified. By a similar change at Oxford in 1905, by which Sir (then Dr.) William Osler was transplanted from the Johns Hopkins Hospital, Baltimore, the two older universities were represented by a pair of Regius professors with a world-wide reputation, such as had never before fallen to their lot, for clinical experience and scientific attainments. There were, indeed, some curious coincidences in the lives of these two friends: they became members (1878) and fellows (1883) of the Royal College of Physicians in the same years, gave the Goulstonian Lectures in successive years, and, though these are the almost natural duties of such Regius professors, delivered the Harveian Oration at the College, and edited successful "Systems of Medicine" which have gone through two editions and are destined for a third in the near future by other hands.

Thomas Clifford Allbutt, the son of the Rev. Thomas Allbutt, Vicar of Dewsbury in Yorkshire and friend of Charles Waterton the naturalist, was born on July 20, 1836, and was named Clifford after his godfather, an artist, who married his father's sister, and whose son Edward Clifford painted the portrait of Lady Allbutt hanging in his study at St. Radegund's, Cambridge. Before the Allbutts' time, Patrick Brontë had been one of the curates at Dewsbury, and they knew his famous daughters well; Sir Clifford regarded it as a sacred duty to contradict the impression given in Mrs. Gaskell's Life of Charlotte Brontë that the family were isolated and not in touch with the country people.

Educated at St. Peter's School, York, he went up in 1856 as a classical scholar to Gonville and Caius College, Cambridge, and his name was the only one in the first class of the Natural Science Tripos for 1860 with distinc-

tion in chemistry and geology. Entering on November 5, 1858, as University students then usually did, the Medical School of St. George's Hospital, and while a clinical clerk for Dr H. Bence Jones, F.R.S., secretary of the Royal Institution and an ardent chemist, he became interested in acute aortitis, a subject which afterwards much engaged his attention in connexion with his view of the causation of angina pectoris. With Lockhart Clarke, who was then working at the hospital, he was on friendly terms, and was influenced by his microscopical investigation of the central nervous system, while to J. W. Ogle he ascribed the stimulus to apply the ophthalmoscope to general medicine. He took the M.B., Cambridge, so early as 1860 and the M.D. eight years later. After leaving St. George's he spent some time in Paris following the teaching of the great Trousseau, and about 1862 settled down to practice in Leeds, where he was attached to the Royal Infirmary (1864–1884), and had a most extensive consulting practice in Yorkshire and the North of England, while at the same time carrying out much research and literary work.

In 1889 Allbutt left Leeds for London on accepting a Commissionership in Lunacy, and thus became associated again with Sir James Crichton-Browne, with whom he had worked at the West Riding Asylum; but his stay in London was cut short in 1892 when, after first refusing, he was persuaded to succeed Sir George Paget as Regius professor of physic in the University of Cambridge. For the remaining thirty-two years of his extremely active life, though taking a prominent part in the medical activities of the University and of the country in general, sitting on commissions and numerous committees, he was no longer driven by the exigencies of a busy consulting practice, and thus spare time he utilised to the full and to the great advantage of his medical brethren. A notable service in this respect was the editing of a "System of Medicine" (1896–1899) in eight volumes, which was the lineal successor to the "System of Medicine" (1866–1879) in five volumes edited by Sir J. Russell Reynolds. Allbutt's "System" passed into a second edition (1905–1911) in eleven volumes, and received a well-deserved welcome from the medical profession.

It is difficult to summarise Sir Clifford's contributions to medicine, for in addition to his philosophically minded addresses and historical work, he ranged far and wide over the province of medicine. But his name will be more especially connected with certain advances, in the first place, he did much to introduce the now general use of some instrumental methods in medicine, thus in 1868 he introduced the present form of clinical thermometer in place of the long and unwieldy one previously available, and made many observations on the temperature of the body in health and disease, reading a paper in 1873 on the effect of exercise on the bodily temperature to the Royal Society, of which he was elected a fellow in 1880, and was subsequently councillor for two sessions and vice-president.

In 1871 there appeared Allbutt's epoch-making work, "The Use of the Ophthalmoscope in Diseases of the Nervous System and of the Kidneys, and also in certain other General Diseases," which, in addition to giving his own extensive experience, covered the literature, as his published work always did, in an admirably complete manner. It is worth noting that this monograph appeared in the year of the death of the original inventor of the ophthalmoscope—Charles Babbage (1792–1871)—and that its practical use, and of Helmholtz's later modification, in medicine, though suggested by Sir Spencer Wells, is largely due to the advocacy of Allbutt and of Hughlings Jackson. He also did much to bring in the now familiar use of the stomach tube and the sphygmomanometer for the estimation of blood pressure.

Allbutt's most consistent work was on diseases of the cardio-vascular system; in 1868 he gave one, if not the first, of the descriptions of syphilitic disease of the cerebral arteries, buried in the now extinct St. George's Hospital Reports; two years later he insisted on the effects of overwork and strain on the heart and great vessels, published in the same series; since 1895 he had described hyperpiesia or high blood pressure of obscure origin, and insisted that it was not secondary to arterial disease or necessarily to nephritis. Angina pectoris has been variously explained, the most popular view being that it is due to disease of the coronary arteries of the heart, but since 1894 he argued that its real cause is disease of the first part of the aorta. His observations on these various subjects were collected in 1915 in his "Diseases of the Arteries, including Angina Pectoris" (2 volumes, Macmillan), and there is in the press a supplementary work on "Arteriosclerosis: A Summary View." Though he wrote much, he did so with a very critical and careful eye, and, as mentioned in his "Notes on the Composition of Scientific Papers," now in a third edition, he usually made four drafts at least before the manuscript was ready for the printers. The finished charm of his writings aptly corresponded to his personality.

A wide reader, he was most generous in recognising good work by unknown men, and though advanced in years always maintained the mental elasticity of youth. This was, indeed, in keeping with his physical activity; for, like his friend the late Sir Hermann Weber, he was until well on in years a keen Alpine climber; as he wrote to the *Times* a week or so before his death about the proposed alteration, artistically for the worse, of the bridge over the Rotha's "living wave" at Grasmere, he had walked in the Lake District almost every year since he was fourteen, and he rode a bicycle or tricycle last year. With a now somewhat old-fashioned courtesy he was independent, and on occasion spoke out vigorously against what he thought wrong; for example, his castigation of the practices of some gynæcologists in his "Visceral Neuroses" (1884), and more recently his disapproval of psycho-analysis. What would be eagerly sought as honours by many men came by natural right to this beloved physician, and deservedly the list is too long to detail. They were accepted with pleasant expressions of modesty and appreciation, but it could not but be felt that the givers of honorary degrees and medals really honoured themselves by their award. He was made K.C.B. in 1907, and a Privy Councillor in 1920, and could, had he desired it, have been made a peer. English-speaking medicine can well be proud of its great and broad-minded leader.

HUMPHRY ROLLESTON.

THE death is announced from America of Dr. Joseph Clark Hoppin, the well-known classical archæologist. Dr. Hoppin was a graduate of Harvard University, and at one time was professor of classical archæology in Bryn Mawr College, Philadelphia, but relinquished this post to devote himself to research. He was a student at the American School of Archæology at Athens in 1892-3, and took part in the excavations carried on in the Argive Heræum between the years 1892 and 1895. When the work of excavation came to an end, he took charge of the Department of Ceramics and was responsible for the examination and classification of the large quantity of pottery in the Museum at Athens which had been obtained from the Heræum site His "Handbook of Attic Red-Figured Vases," a standard authority, appeared a few years ago, and his book on "Greek Black Figured Vases" appeared only at the end of last year He had devoted himself for many years to the formation of a collection of classical antiquities, and it is said that his collection was perhaps the most complete of any in private hands in the United States The value of his work had been recognised in Great Britain by election to honorary membership of the Society for the Promotion of Hellenic Studies, an honour which he greatly appreciated. According to a sympathetic notice by one of his former colleagues in Athens, which appeared in the *Times* of February 4, he had projected further excavations, at his own expense, shortly before his illness, in the Argive Heræum.

THE *Chemiker Zeitung* records in a recent issue the life and work of Dr. Richard Escales, who died on September 9 at Munich. Dr Escales' name will be remembered chiefly in connexion with his work on explosives He was born on July 8, 1863, at Zweibrücken, where his father owned a textile factory. After studying at Würzburg, Munich, Erlangen, and Zurich, he graduated in 1886, and for a while was engaged in his father's business. Somewhat later he returned to Munich in order to undertake the study of explosives in the laboratory of Adolph von Baeyer, and in 1898 he discovered *ammonal*, a high explosive containing aluminium powder, which played a prominent part in the War. He sold the patent rights of this discovery for an inconsiderable sum in Vienna In 1902 he founded an experimental station for explosives at Munich, where during the War he acted as director of the department of "Minenwerfer." He compiled a seven-volume standard work on explosives and was the founder and publisher of the *Zeitschrift fur das gesamte Schiess- und Sprengstoffwesen*.

WE regret to announce the following deaths

Dr J Cleland, F.R.S., from 1877 until 1909 professor of anatomy in the University of Glasgow, and afterwards emeritus professor, on March 5, aged eighty-nine.

Dr Willet G Miller, provincial geologist of Ontario, known for his work on the pre-Cambrian and economic geology of Ontario, on February 5, aged fifty-eight

Dr J A Ormerod, registrar since 1909 of the Royal College of Physicians, and Harveian Orator in 1908 and Lumleian Lecturer in 1914 of the College, on March 5, aged seventy-six

Sir William Peck, Director of the Edinburgh City Observatory, Calton Hill, on March 7, aged sixty-three.

Dr J Ward, professor of mental philosophy and logic in the University of Cambridge since 1897, on March 4, aged eighty-two

Current Topics and Events.

MUCH satisfaction is felt in scientific circles that the Prince of Wales has consented to occupy the presidential chair of the British Association for the meeting to be held at Oxford next year, either from July 28 to August 4, or from August 4 to August 11 At a meeting of the General Committee of the Association on Friday, March 6, Sir Ernest Rutherford, who was in the chair, reported that the Prince had intimated his willingness to accept the presidency, and he was, therefore, nominated by the Council to the Committee and elected unanimously. The Prince Consort was president of the Association for the meeting held at Aberdeen in 1859, but since then no other member of the Royal Family has filled that office. British science is greatly honoured by the consent of the Prince of Wales to act as president, and his knowledge of the resources and needs of the Empire is so extensive that whatever he may say in his address at the Oxford meeting will have wide influence upon both science and the community.

A PAPER by Sir Arthur Schuster, "On the Life Statistics of Fellows of the Royal Society," has just appeared in the Proceedings, and at last week's meeting of the Society the author himself gave an interesting summary of conclusions. Previously, the subject had been studied by General Strachey, who, in 1892, communicated a paper based on a statistical examination of the average age of the 15 fellows annually elected, their probable duration of life, relationship to an eventual maximum strength of fellowship, and other considerations The point whether or not a small increase in the number of annual elections is required, in view of the larger scientific output of the country, has been discussed in recent years, but without bringing any change of procedure The number of fellows of the Society at the beginning of 1848, when new statutes came in force, was 768 In consequence of the restriction in the number annually elected, this total was diminished by more than a hundred in the first ten years, by 1912 the maximum had become 455 Since then the numbers show a steady decline On January 1, 1923, there were 439 fellows As regards age at election, Sir Arthur remarks that it is difficult to gauge the effect of the War, but probably it was appreciable. His impression is that the younger men were kept back in their scientific work even when they were not actually in the field; while some of maturer age were substantially assisted in obtaining the fellowship by their War work The youngest man elected into the Society since 1847 was John Lubbock (afterwards Lord Avebury), who entered at the age of twenty-four.

BROADCASTING in Great Britain on a regular and commercial basis started at Marconi House in London in November 1922. The aerial work of the new 2 LO station has been erected on the roof of the Selfridge building in Oxford Street. There are two towers of the lattice type, the top of each being about 250 feet above the roadway. The towers are entirely self-supporting, no guy wires being used. The aerial is of the two-wire type, the distance between the wires being 15 feet, the wires being connected to an insulator on the roof of the apparatus room by two large cage connectors The aerials are made of nineteen strands of No 16 bronze wire and are very heavy. Strings of eight shackle insulators serve to spread and anchor the leading-in cages The machines installed in the power-house are direct coupled motor generator sets running from the supply mains Eighteen kilowatts is taken from the mains Some of this power is needed for the master oscillators which maintain the frequency of the carrier wave perfectly constant. A certain amount of power also is required for the filaments of the many oscillating, modulating and rectifying valves, as well as for the ordinary losses in the machines The amount of power radiated into space is about three kilowatts, and this is the rating of the station The greatly increased power and the greater size and height of the aerial will more than double the range of the present 2 LO broadcasting station The studio, which has always been entirely distinct from the transmitting apparatus, will remain at the B B C headquarters at Savoy Hill, W C.2. As before, it will be connected with the transmitter by special underground cables The new station will shortly be in regular operation, for the experiments already made have proved extremely satisfactory It will be one of the finest broadcasting stations in the world

SIR ARTHUR KEITH, in his discourse at the Royal Institution on Friday evening, March 6, concerning the rate of man's evolution, described the difficulties in the study of this subject due to the varying stature of men and women among all races of mankind, entailing the measurement of many thousand individuals. In searching the ancient burial-places of England, it is found that the people buried in ancient tombs differed in height in the same manner as at the present time It may be said that there has been no great change in the stature of the inhabitants of these islands since the close of the Ice Age The mean average of the modern Englishman of 5 feet 6 inches may be taken as the pivot on which the scales of stature have been balanced for thousands of years. This was shown from a study of fifty ancient skulls from English graves carried out in 1914–15 The evidence obtained from certain fossil remains discovered at Galley Hill in 1888 points to an antiquity of man of no less than 100,000 years. The facts which have been accumulating for some years past on the continent of Europe confirm this conclusion. The discovery of fossil remains made in South Rhodesia in 1921 has disclosed a more primitive human type, but its age has not yet been definitely fixed By studying the facts which arise from the discoveries made in various parts of the world, anthropologists are able to form an opinion as to the rate at which man has come by the present characters of his body and brain; and the evidence which has been accumulating leads them to the conclusion that the evolution of man has been more rapid than many have hitherto believed

THE China Indemnity (Application) Bill passed its second reading in the House of Commons on March 3 without a division, and was referred to a standing committee of the House. The debate was interesting and informing, and as such contrasted favourably with the second reading of the Bill brought in last May by the late administration Mr McNeill's accurate and well-marshalled knowledge of the facts, and his conciliatory attitude, made an admirable impression not only on the opposition, who objected to the changes in personnel made in the contemplated advisory committee, the places of Mr Bertrand Russell and Mr Lowes Dickinson being taken by Prof Southill and a business representative, but also on the members of his own party, who contended that the best expenditure of the fund would be on railways Mr MacDonald in a convincing speech made short work of this contention, while admitting the value of railways in developing national resources He urged that, in this case, the insufficiency of the sums available; the troubles, complexities, and negotiations which would be involved even in capitalising the fund for such purpose, and the psychological effect on the Chinese of so using the fund rendered such a project impracticable.

IN Mr McNeill's opinion the phrase in the China Indemnity (Application) Bill "educational or other," which describes the purposes of the fund, should be interpreted to mean that the object must be something in the nature of education, or, at all events, it must be something which is not absolutely divergent from the main idea. Since, however, notwithstanding this opinion, divergent purposes were pressed on the House, this point, with Mr McNeill's concurrence, will be decided in the standing committee. It may be hoped, therefore, that Mr Somerville's amendment, "educational, medical or other similar purposes," will be accepted These words evidently meet the views which Mr McNeill expressed, and their adoption would relieve the advisory committee of an invidious task As to the constitution of this committee, a present member of it characterised it as "derisory" from a Chinese point of view. Though its object is educational, the Board of Education has no concern whatever in its membership, no medical man has a seat; and, if trade interests are not to be pressed, the inclusion of a Board of Trade official seems undesirable. Besides that, the other members are so occupied with public or private work that the time and attention they would be able to devote to this important work must be limited, and, considering the opportunity of national service which the fund offers, may be exiguous.

THE report of the executive committee of the Empire Cotton Growing Corporation, submitted at the

meeting of the administrative council held on February 25, has underlying it a tone of expectation of a great increase in cotton production in the tropical and subtropical colonies Indeed, many signs point in this direction, and it is a matter of vital importance to the British Empire to grow as much of its own cotton as possible Mr Milligan, formerly Inspector-General of Agriculture in India, and now in charge of the work of the Corporation in South Africa, gives an interesting account of this There will be fifteen men working at cotton problems this year, as against four in 1924. Rhodesia, where the greatest possible interest is being taken in cotton, has so rapidly expanded its area under this crop that difficulties are arising in respect to ginnery accommodation Nigeria is about to start Government farms for the supply of seed The Corporation has appointed a cotton breeder to work in the Sudan. Nyasaland has obtained a reduction in railway rates upon maize, which will form the necessary secondary crop for a rotation, and so on The evidence of the great interest now being taken in Empire cotton, and of the expansion of its cultivation, is growing more marked every day

COL. PURVES, the Engineer-in-Chief of the Post Office, read an interesting paper to the Institution of Electrical Engineers on the "Post Office and Automatic Telephony" on March 5 A general history was given of the development of automatic exchanges The system actually adopted by the Post Office is a development of the Strowger system, now called the "Director System" This system was devised by the Automatic Telephone Manufacturing Co of Chicago, and, on the whole, it was considered better than the other systems. The electric power required for an exchange of 10,000 lines is provided by two 50-volt batteries each of 10,000 ampere-hour capacity The requisite current at peak load will exceed 2500 amperes When a subscriber has finished dialling his instrument he hears immediately the "ringing tone" which tells him that the required subscriber is being rung up, or the "busy tone" which tells him that he is engaged. The extreme complexity of modern automatic circuits and equipment is illustrated by the fact that a single automatic switching unit of 10,000 lines comprises no less than 5 million contacts. Any one subscriber in an exchange of this size can obtain connexion with any other subscriber by 240,000 different linkages. To reach all the subscribers in his unit he has 2400 million different linkages at his disposal. When we consider the large number of other exchanges he can get in contact with, the number of linkages is enormously increased. Graduated courses of instruction are now being given to the skilled workmen who will maintain the exchanges in working order. The inspectors and engineers who will have to be responsible for the mechanism and the efficiency of the service are also being specially trained.

COL. PURVES, in his paper referred to above, points out that the modern automatic calling dial is a remarkably simple piece of apparatus considering the immense complexity of the machine which it controls This simplicity is the result of a long period of evolution since some one in the Automatic Electric Co first had the happy thought of making a rotating disc with finger holes for the purpose of sending the trains of impulses required for the Strowger automatic system. The master patent secured a monopoly for this device from 1898 to 1912 During this time a great amount of ingenuity was expended in inventing other signalling devices which would not infringe this patent During all this period an old and forgotten telegraph device, invented by Cooke and Wheatstone not later than 1839, anticipated in all essential respects the terms of the master patent It was found during a clearing up of an old storeroom of the General Post Office in 1913, when the master patent had just expired It anticipated all the explicit claims of this patent. It is curious that a patent controlling such large commercial interests, and considered unassailable for fourteen years, should have been so completely anticipated by the earliest pioneers of telegraphy.

D N. PRIANISHNIKOV, the eminent Russian professor of agriculture, whose thirtieth anniversary of his scientific work is being celebrated in Moscow during this month, was born in 1865 in Kiachta, S.E Siberia After completing his course at the school at Irkutsk he entered the University of Moscow, but soon left it to take up studies in the Agricultural Academy at Petrovskoje, near Moscow, in 1888 he passed his final examinations, and was offered a post-graduate scholarship In 1891 he was sent abroad to study the agricultural chemistry and physiology of plants, mainly in Germany, with Prof. Schulze In 1891 he was appointed lecturer, and in 1895 professor of agriculture in the Agricultural Academy of Petrovskoje, a post which he still holds, so that through his laboratories passed many hundreds of Russian agricultural specialists. In his scientific work Prof Prianishnikov approaches the views and ideas of Bussengo, while his thorough training in the physiology of plants by one of the ablest botanists of the last century, K Timirjazev, and in chemistry by G Gustavson, enabled him to elucidate a long series of most complicated problems, mainly concerning fertilisers and manures and their physiological effects His dissertation for the doctor's degree, on the dissimilation of proteins in connexion with breathing and assimilation of carbon dioxide, which appeared in 1899, has been followed by numerous other works, about 200 in number, mainly in Russian and German agricultural periodicals. Two of his books, a course of agriculture, and a handbook on fertilisers and manures, are amongst the best of their kind, the latter having been translated into Polish and German The influence of Prof. Prianishnikov's works and of his teaching on the progress, especially of research work, in Russian agriculture cannot be overestimated Hundreds of his former pupils, with whom he always keeps in touch, have been and still are working in different parts of Russia, developing his ideas and accumulating scientific data. For an agricultural country like Russia, scientific workers

of Prof. Prianishnikov's type must be (if not always are) considered amongst the principal factors in the progress of the country.

In the official report, issued by the Textile Institute, of Proceedings of the first Empire Textile Conference (held at the British Empire Exhibition at Wembley in Whit-week 1924) accounts are given by the Directors of the Cotton, Woollen, and Linen Research Associations of the present position of scientific research in textiles and of the advantages that must necessarily follow from persistent application of scientific method to problems of the trade Numerous examples are given of spinning, weaving, and finishing problems which are now being investigated by the research associations, and attention is directed to the unlimited field for further research on matters the solution of which will be of the utmost national and Imperial importance from the points of view of the grower of the raw material, the manufacturer and the user In addition, the first part of the report contains sixteen papers dealing with exceedingly wide interests, including Empire supplies and consumption of wool and cotton, the possibilities of the British silk trade and the statistics of the textile export trade. It is pointed out that the rapid increase in wool consumption during the last twenty years has been accompanied by an enormous decline in wool production, and an appeal is made to our great overseas Dominions to rectify this lack of proportion. The vast economic importance of the cotton trade is referred to, and it is emphasised that as this is the largest manufacturing industry in Great Britain, the importance of increased Empire production of raw cotton, upon which the stability of this great industry must ultimately depend, is a matter of grave concern if the trade is to retain its pre-eminent position in the world's markets The decline of the British silk trade in the last fifty years has been considerable, although the Empire demand is sufficient to warrant a four-fold expansion of British trade in this material. The second part of the report contains eleven scientific papers on the physical and physico-chemical problems relating to textile fibres, and a discussion thereon (held in conjunction with the Faraday Society), an account of which appeared in NATURE for July 5, 1924, p 27

The Faraday Medal of the Institution of Electrical Engineers will be presented to Sir J. J Thomson at the ordinary meeting of the Institution to be held on Thursday, March 19, at 6 P M. The presentation will precede the reading of Mr S. Evershed's paper on "Permanent Magnets in Theory and Practice"

The Society of Glass Technology has established a small Research Fund for the purpose of promoting research in subjects related to glass technology. Grants from this fund will be made to assist in conducting specified items of research approved by the Council of the Society Applications should be addressed to the Secretary, Society of Glass Technology, Darnall Road, Sheffield

The annual prize of the American Association for the Advancement of Science for the 1924 meeting at Washington has been divided and awarded as two prizes of five hundred dollars each, to Dr. L. R. Cleveland, of the Johns Hopkins School of Hygiene and Public Health, for his work on the physiology of termites and their parasites, and to Dr. Edwin P. Hubble, of the Mount Wilson Solar Observatory, for his work on the nebulæ.

The Hon. W. G. A Ormsby-Gore, M P., Under-Secretary of State for the Colonies; Sir Frank Heath, Secretary of the Department of Scientific and Industrial Research; and Sir Richard Gregory will be the principal guests at the annual dinner of the National Union of Scientific Workers to be held at the Adelaide Gallery (Gatti's Restaurant), King William Street, Charing Cross, on Thursday, March 19 The president of the Union, Prof. G. H Hardy, will be in the chair

The Fison Memorial Lectures, which have been established in memory of the late Dr. A H Fison, lecturer in physics at Guy's Hospital Medical School, and Secretary of the Gilchrist Educational Trust, will be inaugurated on Thursday, May 7, when the first lecture will be given by Sir J. J Thomson, Master of Trinity College, Cambridge, who will take as his subject, "The Structure of Light" The Right Hon. The Earl of Balfour will preside at the meeting.

The Huxley Medal of the Royal Anthropological Institute has been awarded to Sir William Ridgeway, Disney professor of archæology in the University of Cambridge, in recognition of his services to anthropological science, particularly in connexion with the study of the archæology of the Mediterranean area. Sir William Ridgeway, who was president of the Royal Anthropological Institute in 1908 and 1909, will deliver the Huxley Memorial Lecture in 1926. The Huxley Memorial Lecture for 1925 will be delivered by Sir Arthur J Evans in November next.

Lieut.-General Sir William B. Leishman, Director-General, Army Medical Service, Hon. Physician to the King; Sir Richard Lodge, professor of history, University of Edinburgh; and Mr William Rothenstein, Principal of the Royal College of Art, South Kensington, have been elected members of the Athenæum under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

The spring conversazione of the staff of the Natural History Museum was held in the Board Room on March 4, and attracted the usual large attendance of members and visitors On this occasion most of the exhibits were selected to illustrate desert conditions and the effect of desiccation. They included fulgurites (lightning tubes), desert roses, and etched pebbles (the cause of the peculiar markings of which still remains an unsolved problem); Coleoptera, Diptera, and Lepidoptera, illustrating the development of desert colour; hares, rats, mongooses, and birds, showing the effect of desert environment; lizards illustrating modifications in the scales, eyes,

and feet, and desert plants showing the development of spines and prickly leaves as a protection against thirsty and hungry animals. Among the exhibits was a remarkable specimen of *Helix desotorum*, the common desert snail of Egypt, which was fixed on a tablet in the Museum in March 1846, and was found in March 1850 to be still alive after four years in a Museum case without food or moisture. The snail became torpid in October 1851, and was found to be dead in May 1852. Among the general exhibits may be mentioned specimens illustrating a recent study of the occurrence of Gongylonema in Italy by Dr L. W. Sambon and Dr H. A. Bayliss.

A JUNIOR scientific assistant is required by the Admiralty for research work. Candidates must possess an honours degree in physics or its equivalent, have a good knowledge of general physics, and have had some experience in research. Applications should be sent to the Secretary of the Admiralty (C.E.), Whitehall, S.W.1.

THE Experimental Department of H.M. Signal School, Portsmouth, invites application for a junior scientific assistantship from holders of an honours degree in physics or its equivalent. Applications should be sent, with particulars of qualifications and with testimonials, to the Secretary of the Admiralty (C.E.), Whitehall, S.W.1, not later than April 7.

WE have received from the Castner-Kellner Alkali Co., Ltd., a pamphlet on sodium peroxide. This compound was discovered by Gay Lussac and Thenard about 1810, but it was not until 1891 that it was manufactured on a large scale. The properties are described and the method of using the substance for bleaching purposes is set out in some detail. Useful tables of acid densities, etc., are also included in the booklet.

AN interesting tour in the Dordogne and Vézère Valleys during the Easter vacation (April 9-25) has been organised by Prof. Patrick Geddes. It will include visits to the principal prehistoric sites and caves in the neighbourhood of Les Eyziès under the guidance of Dr. Peyrony, the curator of the Musée Archéologique, who will also conduct the party around, and demonstrate, the collections in the museum. Dr. Peyrony has recently published an account of the investigations carried out by himself in company with L'Abbé Breuil and Dr. Capitan at Les Combarelles, and this opportunity of visiting the classical sites of palæolithic art and culture under his guidance should appeal to all who are interested in prehistoric archæology. The second part of the tour will be devoted to a series of excursions for the purpose of the study of the geography and history of the most attractive portions of the Dordogne Valley, Domme being taken as the centre. These excursions will be conducted by M. Paul Réclus. Particulars may be obtained from Miss M. M. Barker, 152 Abbey House, Victoria, S.W.1.

THE Women's Electrical Association has been formed with the immediate object of promoting the wider use of electricity in the service of women, and a large and representative council has been formed to guide its activities. Lectures and demonstrations of the applications of electricity are in hand, and the study of electrical applications in universities, colleges, and schools, particularly in relation to domestic subjects, is to be promoted. It is also proposed to institute a junior section which will be more especially concerned with girls' schools and colleges. Particulars can be obtained from the director of the Association, Miss C. Haslett, 26 George Street, Hanover Square, W.1.

WE have received a copy of the first issue of a new Italian monthly review entitled *Leonardo*, devoted to Italian culture in all its varied aspects, and published in Rome under the auspices of the Leonardo Trust and the editorship of Giuseppe Prezzolini. The review is illustrated, and is to be conducted apart from political influence and from the influence either of any literary or philosophical school, or of any firm of publishers. Its aims are not merely bibliographical, but comprise the study of cultural activities of all forms: scholastic, journalistic, theatrical, and even cinematographical. This first number contains, among other contributions, articles on the second International Book Fair, to be opened in Florence at the end of April, on the work of several Italian authors, and on British literature relating to Italian matters, together with a number of reviews of Italian books dealing with art, philosophy, hygiene, the literature of Italy and other countries, linguistics, medicine, pedagogy, geography, religion, social and political sciences, history, and the theatre. It is well produced, and should command a wide circulation, both in Italy and elsewhere.

THE Cambridge University Press announces for early publication vol. 1 of a new edition of "Principia Mathematica," by Prof. A. N. Whitehead and the Hon. Bertrand Russell. There will be three volumes in all.

AN interesting catalogue (No. 467) of some 1300 second-hand books on anthropology, folk-lore, archæology, and sociology has just been issued by Mr. F. Edwards, 83 High Street, Marylebone, W.1. Copies can be obtained upon application.

WE learn that Messrs. J. W. Atha and Co., who are the distributors for Messrs. Carl Zeiss, Jena, have now transferred their business to larger and better equipped premises at Winsley House, Wells Street, Oxford Street, London, W.1.

THE Schlomann-Oldenbourg Illustrated Technical Dictionaries in English, French, German, Italian, Russian, and Spanish, are familiar works. A British office has now been opened with Mr. H. I. Lewenz as editor and manager, and he will be responsible for the English terms and phrases contained in the dictionaries. Volumes are to be issued shortly on weaving and woven materials, on mining, agricultural machinery, chemistry, gas engineering, etc. The work is issued and stocked by Messrs. Lewenz and Wilkinson, Ltd., 25 Victoria Street, Westminster, S.W.1.

Research Items.

FURTHER EXCAVATIONS AT SOLUTRÉ.—*La Nature*, February 14, contains an illustrated report of the excavations at the prehistoric station of Crot-du-Charnier, Solutré, in 1924, which was presented to the Paris Academy of Sciences by MM. Depéret, Arcelin and Mayet on December 15 last. The trench in which three skeletons were found in 1923 was carried farther to the west and revealed the continuation of the thick, undisturbed bed of horse-bone magma. Immediately beneath this was found a fourth skeleton, a male, of Aurignacian age, as was revealed by the associated implements — gravers, flakes, scrapers, etc. Three stone slabs were placed on a level with the head. The legs of this skeleton had been destroyed by the excavations of the Abbé Ducrost in 1875. A fifth skeleton was that of a young woman which lay, not beneath, but actually in the horse-bone bed, which showed no sign of disturbance The skeleton had clearly been buried there during the period of formation of the bone-bed, which is nothing but the kitchen refuse heap of the Aurignacian hunters, who fed on the horse. This skeleton had no sepulchral slab A detailed description of the skeletons by Dr. Mayet is in course of preparation A preliminary report shows that the fourth skeleton is a male of about 40 years of age, in height 1·67 m to 1·70 m , dolichocephalic, but with a tendency to brachycephaly—index 77 89 The cranium is relatively high, the face broad but low, with prominent cheek bones, orbits quadrangular, low and elongated with an index of 69·7. The fifth skeleton is a female of about 30 years, in height the same as skeleton No. 1—1·53 m. to 1·55 m —cephalic index 83·24, face broad and very low, orbits oblique, oval and mesoseme—index 86·5. In general it shows a striking resemblance to the female skeleton No 1 found in 1923 The suggestion that the women belong to a different ethnic group is plausible, although it is recognised that in many ethnic groups the men are big and the women small.

BRONZE IN CHINA.—M A. Vayson de Pradenne, in collaboration with M G Chesneau, Director of the École Nationale Supérieure des Mines, has published in *L'Anthropologie*, T. 34, 6, a metallurgical and archæological study of bronze weapons from China, with special reference to two swords and a halberd which are tentatively assigned to the end of the Bronze Age The interest of the three weapons in question lies in the fact that not only are they in an excellent state of preservation, but also that they had been tinned The tinning had taken place after the smoothing and polishing process which followed the casting An analysis of the bronze shows: tin 16 44, copper 82·32, lead 0·15, iron 0·43, zinc 0·20, and of manganese, nickel, and arsenic, traces only. The superficial area shows tin only, with traces of copper at the point of contact with the bronze. The bronze is therefore of a composition which gives the maximum hardness without being brittle, the limit for a weapon which was to receive blows without risk of fracture being put at 16·17 per cent. of tin. It is suggested that the tinning was a device to obtain greater hardness without increasing the brittleness of the weapon The superposition of tin on the bronze has produced a thin hard layer which offers greater resistance than the inner metal to a steel drill. It is clear that the weapons have been ground and polished after tinning so that the layer of harder metal forms the cutting edge.

CLIMATE AND PLANT DISTRIBUTION IN THE LIGHT OF THE FOSSIL RECORD.—In the Masters Lectures published in the Journal of the Royal Horticultural Society, vol. 50, part i., January 1925, Prof. A. C. Seward gives a delightful account of Arctic vegetation as studied by him in his Greenland visit of 1921. The keynote of his lectures is to be found in a vivid passage in the first paragraph, in which he speaks of the experience of collecting a fossil frond of a Gleichenia, similar to the living frond he had seen in a Malayan forest, from the rocks below a flower-sprinkled Greenland heath. Prof. Seward attempts to answer the question whether the fossil record of these Arctic latitudes, as symbolised by this Gleichenia, necessitates the assumption that in preglacial times tropical climatic conditions prevailed in these northern climes He points out that the wide range of climate and altitude covered to-day by Gleichenia suggests the need for caution in drawing such a conclusion. His analysis of the modern Arctic flora, with its dominant herbaceous perennial type, certainly contrasts strongly with the arboreal character of many fossil remains from these latitudes, but Prof Seward makes it clear that modern investigation has not yet justified the assumption that structure has been directly and profoundly modified by Arctic conditions His cautious inference appears to be that the contrast of living and extinct floras of Arctic regions like Greenland justifies the assumption of considerable climatic change such as would accompany the changes in the distribution of land and water, of land elevation and water circulation, that might be expected in vast periods of time, but do not involve the assumption of changes in the position of the earth's axis of a nature that the astronomers are not ready to concede.

DYING-BACK OF ROSE SHOOTS.—In the Journal of the Royal Horticultural Society, vol. 50, part i., January 1925, W J Dowson describes very fully a disease met with on rambler roses in the Society's garden at Wisley The organism responsible for the dying-back of the rose shoots proved to be an ascomycete with small perithecia and was identified as *Gnomonia Rubi*, Rehm. After culture of the isolated organism, successful inoculation experiments were carried out, and no doubt remains that this organism was responsible for the disease. Other occasional records of this parasite, together with field observation, suggest that whilst the fungus may be widely distributed (on brambles and roses) it is relatively rare and seldom does much damage to roses, in this case probably entering the plants through buds previously killed by frost.

SOME INDIAN EARTHWORMS.—Dr. J. Stephenson (Records Ind. Mus., 26, pp. 317-365, 3 pls., 1924) gives an account of some Indian earthworms and describes two new genera of Ocnerodrilinæ. Only a single endemic species—*Gordiodrilus travancorensis*—of this family has until recently been known in India. Michaelsen described a second—*Curgia narayani*—in 1921, and now Stephenson describes two new genera, Malabaria and Aphanascus, which belong to this family. Malabaria is probably the immediate ancestor of Aphanascus, and the latter very possibly leads on to Curgia. The discovery of these worms strengthens the evidence of a faunistic relationship between India and E. Africa. The author refers to the interest of the occurrence of the two new genera in the same place (South Malabar) and surmises that the origin of the younger genus Aphanascus has taken place here and at no remote period, and yet the morphological differences between the two genera are not inconsiderable. It would appear that large morphological changes—sufficient to give rise to new

genera—" may come about in no great length of time, and that evolution may proceed, at times, with large strides and at a rapid pace." The paper forms an interesting addition to the author's analysis of the phylogeny of Indian Megascolecidæ.

THE MEDUSÆ OF THE MEDITERRANEAN AND ADJACENT SEAS.—In the reports on the Danish Oceanographical Expeditions, 1908-10, to the Mediterranean and adjacent seas (vol. 2, pp. 67, 1924) Dr. P. L. Kramp describes the collection of medusæ—Anthomedusæ 8 species, Leptomedusæ 6, Trachymedusæ 11, Narcomedusæ 4, and Scyphomedusæ 6, and gives figures of the species and maps showing the distribution of many of them. No new species was secured, but the collections have increased our knowledge of the range of distribution. Of the 27 species collected in the Mediterranean, only one was a new record for that sea, but several species hitherto known from but a few localities have been found to be widely distributed, and 3 species hitherto known only from the Mediterranean have been found to occur in Cadiz Bay. Of the 17 species found by the *Thor* in the Atlantic, between the south coast of Ireland and the north coast of Morocco, seven—chiefly deep-sea forms—do not enter the Mediterranean. Dr. Kramp discusses in some detail the connexion between the distribution of the species and the hydrographical conditions.

PHILIPPINE EARTHQUAKES.—The Rev. M. Saderra Masó, who has studied the Philippine earthquakes for so many years, gives a catalogue of 52 earthquakes of intensities 7 to 10 (Rossi-Forel scale) during the years 1901-22 (Weather Bureau, Manila Central Observatory, for September 1922). Of these, 31 were strong enough to damage buildings. Most of them originated under the neighbouring parts of the China Sea, the Celebes Sea, and the Pacific, those taking place beneath land or the inter-island seas being of slighter intensity. In all cases, the areas of destruction were those occupied by alluvial deposits. As a rule, only poorly-built houses were injured, with one curious exception. During an earthquake in 1907, a modern addition to the front of an old building was entirely demolished, while the original portion suffered no injury.

STRUCTURE OF A DENDROID GRAPTOLITE.—The structure and development of an early form of Dictyonema from the Upper Cambrian of Shropshire has been studied by O. M. B. Bulman (*Geol. Mag.*, 1925, p. 50). The work was facilitated by using a method for separating the fossil from the matrix in which it was embedded. It is found that this species of Dictyonema approaches the true graptolites more nearly than do the later forms of the genus, since it shows no true common canal and no spiral arrangement of the hydrothecæ, both of which characters are present in Silurian species. This suggests that the dendroid graptolites have been derived from the true graptolites. The hydrothecæ are of two kinds, the smaller (called bithecæ) are budded off from the sides of the larger, and it is suggested that they lodged polyps of the nature of dactylozoids. The hollow transverse bars (dissepiments) joining the stipes are formed as outgrowths from the bithecæ.

NEPHELINE-SYENITES IN RAJPUTANA.—In the Records of the Geological Survey of India (vol. 56, part 2, pp. 179-197, plates 2-12, 1924) Dr. A. M. Heron gives an account of the nepheline- and sodalite-bearing syenites of Kishengarh in Rajputana. These are of unusual interest on account of the occurrence, in some of their pegmatitic forms, of a peculiar sodalite which, when broken, is pale crimson on the freshly-opened surfaces, but rapidly turns to pale grey on exposure to bright daylight. The occurrence of this strange phenomenon was noticed first about twenty years ago (Rec. Geol. Surv. Ind., 31, 43, 1904; 32, 158, 1905), but its cause has never been worked out. During the visit of the British Association to Canada last year a similar peculiarity was noticed by members of a geological excursion party whilst examining the nepheline-syenite area in the Bancroft area, Ontario; and the change of colour, similarly from crimson to pale grey, is shown in this instance by white translucent sodalite. In the Kishengarh area the ordinary deep-blue sodalite occurs, as well as the variety which changes its colour. The felspathoid-bearing syenites of this area show considerable variations over a band some ten miles long and two miles broad. They occur mainly as sill-like intrusions among the Archæan schists, elongated in the direction of the general strike and often themselves both foliated and banded; but occasionally there are non-foliated pegmatitic forms with individual crystals of nepheline (elæolite) a foot or so in diameter. Among the accessory minerals of interest are thulite, cancrinite, and calcite, the last named being regarded as a primary constituent formed direct by consolidation of the magma, as in the case at Sivamalai, in South India, described by Holland in 1901 (Mem. Geol. Surv. Ind., 30, 169-217).

SWEDISH OCEANOGRAPHY.—Among the many valuable publications on Swedish meteorology and oceanography is the record made on certain lightships moored off the coasts of Sweden in the Gulf of Bothnia, the Baltic, and the Cattegat. The data from ten lightships for 1923 has now appeared (Svenska hydrografisk-biologiska kommissionens Fyrskepp-undersökning). In some cases the data for the year are incomplete, because ice necessitates the withdrawal of the lightship in winter and early spring. The first part of the volumes gives the noon records, including water temperatures at various depths and currents for the days each lightship was functioning. This is followed by salinity records, while the final part has a valuable series of water temperatures at different lightships at various depths in all months of the year for the years 1880 to 1913. This shows some remarkable variations in the Gulf of Bothnia and in the Sound.

BENTONITE.—The Canadian Department of Mines has recently issued an interesting paper on bentonite (Mines Branch, Pub. No. 626, by Hugh S. Spence, 1924), a peculiar clay-like material concerning which very little information has hitherto been available. Bentonite occurs in Wyoming and other western states of America, and appears to be widespread over the prairie provinces of Canada. It is found as a bedded sediment in thin deposits rarely so much as ten feet thick, most of which are of Upper Cretaceous age. Its most curious property is its tremendous swelling power when water is added. The volume at the maximum absorption may be five to thirteen times the dry bulk, and the mixture behaves like a true colloid. Nevertheless, the deposit is mainly composed of minute flakes of the definite mineral leverrierite, $2Al_2O_3 . 5SiO_2 . 5H_2O$. It also contains a noteworthy amount of adsorbed soda, and a further curious feature is that soda is frequently five times as abundant as potash. The origin of bentonite is traced to the hydration of thin water-laid beds of fine vitreous volcanic ash. The clay particles appear to have become dispersed as a suspension which afterwards coagulated and settled. The peculiar properties of bentonite should ultimately

give it an industrial importance, though at present there is only a small demand, largely on account of the high cost of transport. It has already been used as the base of many toilet creams and cosmetics; as a suspending agent in enamel mixtures, in the paper industry, and in the refining of oils and fats. The paper gives a long list of other possible applications, and a bibliography of the literature.

AMERICAN ASPHALT INDUSTRY.—Mr. K. W. Cottrell's report on "Asphalt and Related Bitumens in 1923" (Mineral Resources of the United States, part 2) indicates further progress in this industry, reflected especially in the marketing returns for that year. In the case of natural products the increase amounted to 22 per cent. in quantity and 28 per cent. in value over the previous year Manufactured asphalt from domestic petroleum, obtained chiefly from refineries in California, Texas, and Illinois, advanced 24 per cent in quantity and 26 per cent in value The total amount of asphalt produced from internal sources during 1923 amounted to 1,395,890 tons, corresponding to a market value of nearly sixteen million dollars To this must be added 1,378,722 tons manufactured from petroleum imported into the United States from Mexico, from which it may be observed that practically 50 per cent of the total output of asphalt in America is of Mexican origin Save for its utilisation in the paper-making industry (see NATURE, December 13, 1924, p 873) asphalt has apparently not found any new use during the year under review, the bulk still being employed for paving, roofing, and waterproofing purposes, though the rubber industry's demands have been heavier than in previous years The British Isles is still the largest consumer of asphalt and asphaltic products, Australia, Canada, France, Japan, Spain and Germany following in that order. The American asphalt industry now has its own Asphalt Association, a body composed of manufacturers, consumers and technical experts, whose purpose it is to disseminate practical information Co-operation of this kind, always a popular movement in the United States, is a sure sign of growing commercial activity in any industry, and in the present instance the trend of events is indicated by the fact that there are no less than forty independent groups operating in the country which are concerned with the production of asphalt and allied bituminous commodities.

THE MERCURY VAPOUR ENGINE.—One of the addresses delivered at the centenary of the Franklin Institute in September last dealt with the mercury vapour engine invented by Dr W. L. R. Emmet, of the General Electric Company, and it is printed in the February issue of the Journal of the Institute. The mercury is vaporised in a boiler at about 35 lb. per square inch pressure and passes to a mercury turbine coupled to a generator giving about 1800 kilowatts The waste heat of the vapour leaving the turbine is utilised in a tube steam boiler giving steam at about 200 lb. per sq. in. The condensed mercury runs back by gravitation to the mercury boiler. The furnace gases from the mercury boiler are used to heat the returning liquid mercury, then to superheat the steam raised in the steam boiler, and lastly to heat the feed water for that boiler. The plant has been run for several months at Hartford and has delivered power to the circuits for 800 hours without any troubles of a serious nature arising. A plant of 50,000 kilowatt capacity is to be installed at Chicago and a gain of output of 50 or 60 per cent. as compared with a modern steam turbine plant of that capacity is expected.

COLD-WORKING OF METALS AND HARDNESS.—The issue of *Die Naturwissenschaften* of January 2 contains an interesting article by Masing on the cold-working of metals and the resulting hardness produced, considered in the light of the modern work on single metallic crystals of Carpenter, Elam, and Taylor in Great Britain, and Polanyi, Mark, Schmidt, and Czochralski in Germany. The knowledge now gained is the result of a detailed study of the deformation of single crystal test pieces under stress which involves an experimental determination of the movement of the crystal axes during the test. The work of Taylor and Elam is especially noteworthy in this connexion. In their Bakerian Lecture two years ago they showed that in the distortion of a single crystal test piece of aluminium, the metal was deformed by movement on one octahedral plane up to an extension of 40 per cent. After this the crystal axes had moved in such a way that a second octahedral plane came into the conjugate position, and from there onwards the crystal elongated by being pulled out on two planes A point of special interest which emerged from their analysis was that the hardening of the crystal was general and not local, since, when the second plane came into position, the metal was equally resistant to distortion along this plane and that along which it had already been elongated In their recent paper to the Royal Society, Carpenter and Elam showed that the proportional increase in hardening is greatest during the early stages of extension, but that in the case of single crystals a stage is reached when the increase in hardness is approximately proportional to the amount of plastic deformation.

SULPHURIC ACID MANUFACTURE.—The *Chemical Age* for February 7 contains an interesting account of the new Gaillard method of intensive sulphuric acid production. Acid is sprayed on to the walls of an air-cooled lead tower from a "turbo-disperser" at the top. The impact breaks the drops, which then recoil and form in the body of the tower a heavy acid fog. Burner gases are passed up through this fog, which decomposes the nitrosyl sulphate, and condenses the acid already formed The process has been installed at San Carlos, near Malaga; the yields obtained correspond to a chamber space of 1 2 cu. ft. per pound of sulphur per 24 hours. The process works well with burner gases of both low and high sulphur dioxide content.

FLUCTUATIONS OF ASH AND NITROGEN IN LEAVES.—Jan Wlodek gives some interesting data as to the fluctuations in ash constituents and nitrogen in leaves collected at different hours of the day and night, in the Bulletin de l'Académie Polonaise des Sciences et des Lettres, Séries B, Sciences Naturelles, 1923, pp. 65-78. Many ash constituents show important fluctuations from night to day, these being best seen when the results of analysis are expressed as absolute values per biological unit, the leaf. In all three species investigated (*Phaseolus vulgaris*, *Trifolium pratense*, and *Avena sativa*) the sodium oxide content fell during the night, whilst potassium oxide fluctuated very strongly in Phaseolus, less in Trifolium. Magnesium oxide remained fairly constant; calcium oxide fluctuated irregularly; silica and SO_3 fell markedly during the night; chlorine remained about constant; P_2O_5 fluctuated irregularly. In oats the total nitrogen followed the silica content; in clover it varied irregularly. In oats the protein nitrogen on the other hand increased at night; in clover this also varied without regularity. These somewhat puzzling results are not discussed in the paper.

The Function of the Spleen.

THE number of functions attributed to any organ is often a direct measure of our ignorance as to its real status in the animal economy. The spleen has suffered much from a multiplicity of theories as to its functions, but only two appear to be generally accepted, in fœtal life it acts as one of the sources of the cells of the blood, whilst in the adult these cells, especially the red cells, are here broken down and destroyed when they become worn out. It appears from recent work by Prof. J. Barcroft and his collaborators, an account of which is given in the *Lancet* of February 14, that a further extremely important function must be attributed to this organ, in their opinion it acts as a storehouse for the red cells of the blood, a number of which may be kept there ready to be brought back into the circulation at a time of emergency.

These workers were first led to a study of this question by finding that when the blood volume increases on exposure of the body to a high external temperature, the increase is not entirely due to the addition of fluid alone to the circulating blood, but that at the same time the total hæmoglobin circulating in the blood increases also. There is no evidence of an increase in the number of newly formed red cells until after a few days have elapsed, so that the additional hæmoglobin—and corpuscles containing it—must have come from some store, and not be due to a new formation, at any rate at first; moreover, the rate of appearance of this hæmoglobin is too great for it to be due simply to new formation In their search for this store of red cells the investigators naturally thought of the spleen; if their supposition was to be considered correct, they must be able to answer in the affirmative these two questions: Is there, in fact, a store of red cells in the spleen, which are usually outside the general circulatory stream? Is the number of these stored cells sufficient to account for the increase in circulating hæmoglobin observed on exposure to a high external temperature?

The answer to the first question was found by an examination of the effects of breathing small amounts of carbon monoxide upon the blood in the spleen The experiments were conducted upon a number of different animals, and it was conclusively shown that there was a lag in the taking up of this gas by the red cells in the spleen as compared with those in the general circulation. In fact, if the percentage of gas breathed was sufficiently small, the hæmoglobin in the spleen might still contain none after several hours; on the other hand, when the animal was placed again in ordinary air, the carbon monoxide came off from the blood in the spleen much more slowly than from that in the general circulation. The blood in the spleen is thus outside the circulation, but this statement is only true for an animal at rest; in activity the carbon monoxide penetrates into the organ at once, so that under these conditions the stored blood appears to be in circulation. Further experiments have shown that under conditions where the amount of oxygen in the blood is less than normal, as, for example, after administration of carbon monoxide, the spleen is stimulated to contract by impulses from the central nervous system, the amount of blood forced out depending partly on the degree of such stimulation. Although it has been known for a long time that the spleen can undergo variations in size from the contraction of the unstriped muscle fibres it contains, the reason for this contractility is thus only now becoming apparent. Furthermore, bearing this capacity of the spleen to vary its size in mind, it may be asked: What is the real size of this organ? And are its variations in size of sufficient amplitude to account for the increase in circulating hæmoglobin with increase in the blood volume?

Little information on these questions can be derived from a study of the size of the spleen in the dead animal, since we have no means of knowing whether the muscle in it has maintained its *in vivo* length. We should expect to find, in fact, that it has contracted, so that the organ will be smaller than in life, but how much smaller we cannot judge It is clear that the organ must be examined in the living animal and without subjecting it to any exposure which might stimulate its smooth muscle fibres Since it is not opaque to the X-rays, Barcroft and his co-workers fastened small metal clips to its edges in the living animal under an anæsthetic After the wound had healed, X-ray photographs were taken in two planes, and from these it was easy to reconstruct in a model the size and shape of the organ under different conditions, the approximate weight was also ascertainable, after the animal had been killed, by comparing its size and weight after death with the size found during life It was found that the weight during life might be two to six times that observed after death, in fact, no less than one-sixth of the total blood volume, or one-third of the red cells, might be contained in the organ during life A comparison of its size at rest and during exercise suggests that an amount of blood equivalent to about one-quarter of the blood volume may be squeezed out of the organ during activity The evidence appears conclusive that a large amount of blood may be stored in the spleen, available for emergencies

Finally, since it is known that in man the spleen may be removed without apparent harm to the individual, Barcroft has inquired whether the absence or not of the organ makes any real difference to the organism. He found that animals without spleens died sooner than controls on exposure to an atmosphere containing carbon monoxide Thus an individual with a spleen will be able to meet an emergency with more success than one from whom the organ has been removed.

Science in Russia.

IT is gratifying to learn from a correspondent that, throughout the troubled period of the past few years, the splendid premises and wonderful collections of the famous Zoological Museum of the Academy of Sciences in Leningrad have scarcely felt the breath of war, famine, pestilence, and revolution which has passed over them. When the English traveller walks in, and is greeted by the famous young mammoth from Siberia, preserved like a recently killed specimen, and sees the rich collections illustrating the fauna of the vast steppes and deserts of Russian Asia, he feels that he is entering into a new world

During the cold winter of 1919–1920, when fuel was unobtainable, it was impossible to heat the Museum premises, but the staff suffered more than the collections Little or no looting was done during the disorders, except that the director had some difficulty in preventing the valuable collection of skins from being taken to be used as furs by the shivering population. Far more damage was done

during the severe floods last autumn, when the waters burst into the basement and ground floor, and at least one member of the staff actually saved his own life and that of others by swimming: the library was badly damaged, many valuable specimens were ruined by the water and damp, and great inconvenience was caused by the smashing of the stores of alcohol, which is difficult to obtain to-day in Russia, as the supply is under strict Government control and very limited

The entomological collections were enriched in 1914 by the generous gift by A P Semenov-Tian-Shansky of an immense collection of Central Asiatic Coleoptera, consisting of no less than 800,000 specimens the same donor last year presented his own collection of Hymenoptera, Diptera, Neuroptera.

The staff of the Zoological Museum consists of ten "senior zoologists," who form a "soviet" and elect their own director, ten "keepers," and eight assistants The present director is A A Bialitsky-Birula, well known from his work upon Arctic zoology, who is also editor of the *Annuaire* Birds are under the charge of P. P. Sushkin, Member of the Academy, who is well known in Great Britain and the United States. Another name well known outside his own country is that of the entomologist A. P. Semenov-Tian-Shansky, whose many friends will regret the sad news of his failing eyesight Fortunately, his general health leaves nothing to be desired, and it is to be hoped that he will be spared with capacity for useful work for many years. His father, P P Semenov, was a distinguished explorer, who surveyed the Tian Shan mountains, receiving the authority of the Tsar to add the title Tian-Shansky to his surname. Other well-known members of the staff are N J. Kuznetsov the lepidopterist, G G Jacobson the coleopterist, A K Mordvilko the aphidologist, P. I. Schmidt the ichthyologist, A N Kirichenko and A. M Diakonov, entomologists

The staff of the Museum are, of course, State officials, and paid at least a living wage: the salary of a senior zoologist is 47 gold roubles a month, equivalent to about 5*l* this, of course, leaves no margin for luxuries, but they are at least happy in their devotion to science Their chief complaint has been the shortage of modern foreign literature, but this is now to a certain extent being made good There is, however, considerable leeway to make up, and as the postal arrangements are now working satisfactorily, zoologists in England will be doing good work if they bear this in mind

During recent years it has not been possible to publish the results of research work in agriculture in Russia, since the scanty funds for agricultural publications have been used, in the first place, for publishing popular handbooks and pamphlets At the same time, research work has been carried on, often under most unfavourable conditions, and a considerable amount of new facts is awaiting publication The new journal (*Journal für landwirtschaftliche Wissenschaft*, vol 1 Nos 1-6, Moscow, 1924 (in Russian)), edited by a group of leading professors and research workers of the Moscow Agricultural Academy, aims at becoming a medium for publishing results of research work in all branches of agricultural science The five numbers (one double) before us now include a great variety of papers on different subjects

One of the most interesting papers is by A. G. Dojarenko, on the utilisation of solar energy by plants (No 1, pp 7-21), which describes the methods used in the author's experimental work for exact measurements of solar energy both received and utilised by cultivated plants, and gives interesting, though only preliminary, conclusions. Of considerable general interest is a paper by A. R. Minenkov (No. 1, pp. 29-47) dealing with the problem of chemical determination of sex in plants and in animals; the results of his experimental work are that both in plants and in animals there is a definite sexual difference in the fermenting properties of extract (plants) or blood (animals) which enables one to determine the sex A. D. Prianishnikov (No. 3, pp. 179-190) describes experiments on the transformation of nitrogen compounds in plants and in animals, the author's conclusion being that the analogies in this respect are very far-reaching and suggest a close similarity of processes in plants and in animals. In a paper by V Israilsky and E W. Runov the question of the action of vitamins on bacteria is discussed and experiments described, which tend to show that bacteria are very sensitive to vitamins. G. D. Karpetchenko (No. 5-6, pp 390-410) describes hybrids between two plants of different genera, *Raphanus sativus* L. and *Brassica oleracea* L.; an exhaustive study of the morphology and cytology of hybrids is given These are only a few of the more interesting papers from the journal, which represents, on the whole, an important step in the development of agricultural science in Russia The value of the journal to Russian agricultural research workers is greatly enhanced by abstracts of current literature.

University and Educational Intelligence.

BIRMINGHAM.—The Council of the University at its meeting on March 4 decided to go forward with its purpose for erecting further buildings at Edgbaston to accommodate the three biological departments, botany, zoology, and brewing, with the fermentation industries. The approximate estimate of expenditure is 90,000*l*-100,000*l*, and the scheme is only rendered possible by a very generous donation from Mr. W. Waters Butler of 35,000*l* Another donation to the fund of 5000*l*, given anonymously, was also reported. The Biological Departments are at present quite inadequately housed in Edmund Street, and the release of the space in the Edmund Street buildings will enable rearrangements to be made there to facilitate the work of the Faculties of Arts and Medicine, and the new Department of Law When the University was founded in 1900, an imposing scheme for the site at Edgbaston was planned by Sir Aston Webb Substantial progress had been made when the present buildings were opened by King Edward in 1909. The War and its economic consequences, however, prevented further progress. The new biological block is a resumption, long delayed, of the original plans.

CAMBRIDGE.—It is proposed to confer Honorary Degrees upon Prof. John Joly, professor of geology and mineralogy in the University of Dublin, and on Mr. A. P. Maudslay

The Board of Archæological and Anthropological Studies is recommending certain changes in the regulations for the diploma in anthropology. One change would throw open the diploma to any officer of one of the public services of the Empire, not ordinarily resident in the British Isles, who has resided and received instruction in anthropology in Cambridge during three terms or, in the case of an officer possessed of exceptional qualifications, during one term only.

LEEDS.—The degree of Doctor of Science has been awarded to Mr. H. Hunter for his thesis on "The Improvement of the Barley Crop"; and the degree

of Doctor of Medicine to Mr. C. G. K. Sharp for his thesis on "Bilharzia Disease." Dr. Sharp is the Chief Medical Inspector of Schools, Pietermaritzburg.

LONDON.—A course of three free public lectures on "The Cretaceous Vegetation of Greenland" will be delivered at University College on March 17, 20 and 24, at 5.30, by Prof. A. C. Seward. No tickets will be required.

MANCHESTER.—The Council has appointed Dr F. Craven Moore, lecturer in systematic medicine, to the chair of systematic medicine in the University. Dr. Craven Moore is the author of numerous papers, chiefly in connexion with diseases of the alimentary canal and metabolic medicine, among which may be mentioned "Cholesterin" and "Diseases of the Stomach" (Practical Encyclopedia, Medical Treatment, 1915), "Compensatory and Regenerative changes in the Liver," *British Medical Journal*, 1908; and "The Rôle of Fats in Treatment of Disorders of Stomach" (with Dr Ferguson), *Lancet*, 1909.

OXFORD.—The first annual report of the committee for the Lewis Evans collection of scientific instruments has just been issued by Mr. R. T Gunther, fellow of Magdalen College, the Curator The collection, which has now been appropriately housed in the Old Ashmolean Building, has received several important accessions in the course of the year. Interesting exhibits have also been deposited on loan by various colleges and by private collectors, and good progress has been made in the arrangement and labelling of the collection. That it has been possible to issue so favourable a report of progress in the proper display of this valuable collection is mainly due to the zeal and energy of Mr. Gunther The collection is to be officially opened on May 5, when the Earl of Crawford and Balcarres will deliver an address.

An examination for the Theodore Williams medical scholarship at Pembroke College, Oxford, will begin on June 9. The scholarship is of the annual value of 100*l*. and is tenable for either four or five years. Further particulars may be had from the senior tutor of the college.

DR. OTTO FISCHER, professor of chemistry at the University of Erlangen, who is retiring shortly, will be succeeded by Prof Rudolph Pummerer of Griefswald.

DR. ADOLPH HEILMANN, chief engineer of the municipal waterworks at Dresden, has been nominated to a professorship at the Technische Hochschule in Dresden.

DR. WALTER GOSSNER, professor of mineralogy at the University of Tübingen, has been invited to occupy the chair of mineralogy and crystallography at the University of Munich.

APPLICATIONS are invited for the chair of agriculture in Auckland University College, New Zealand. Particulars are to be had from the High Commissioner for New Zealand, 415 Strand, W.C.2. The completed forms must be returned by, at latest, March 31.

APPLICATIONS for not more than two Ramsay Memorial Fellowships for Chemical Research (one limited to candidates educated in Glasgow) are invited. The annual value of each fellowship is 250*l*., to which not more than 50*l*. for expenses may be added. The fellowships are normally tenable for two years with a possible extension for a further year. Applications must reach the Secretary of the Ramsay Memorial Fellowship Trust, University College, Gower Street, W.C.1, by June 6 at latest.

THE SCHOOLS RADIO SOCIETY, a section of the Radio Society of Great Britain, is arranging a Schools Radio Exhibition to be held at the L.C.C. Beaufoy Technical Institute, Princes Rd., Vauxhall Street, S.E., on March 14-18. Approximately 40 schools are exhibiting, consisting of members of the Schools Radio Society, L C C. Schools, and Technical Institutes. Apparatus made by scholars and sets used in schools will be shown together with schemes of school wireless work, and there will be a special display and demonstration by the British Broadcasting Company of what they consider to be the ideal set for broadcast reception Admission to the exhibition is by purchase of a programme or by invitation to be obtained from the Secretary, Schools Radio Society, St Paul's School, Dorking

AT the meeting of the Association of Technical Institutions on March 6 and 7, Mr G Mavor, head of the Department of Continuative Education at Loughborough College, in a paper on the conditions of training and education of apprentices, stated that the response to the appeal for information on the subject sent out to the leading firms in a great number of trades had been unsatisfactory as only about 10 per cent had replied From the replies received, it is, however, evident that while there may be a feeling in favour of apprenticeship, neither the trade unions nor the employers appear to be willing to enforce it. Where it exists, it is generally of the unindentured form, for 5 years, and not of an all-round type In some cases the local technical schools are asked to provide evening classes, but in the works the training is generally restricted to one branch, with the possibility of unemployment if the demands on that branch decrease To effect reform, Mr Mavor advocates the raising of the school leaving age to 16 and the provision of part daytime education for all employees up to the age of 18 Some firms have already adopted the latter, and others encourage their employees to attend evening classes, but State action is necessary if the requisite number of "warrant officers" for future industrial progress is to be produced

TEACHERS in technical and evening schools are being offered some very attractive short courses of instruction to be held next summer under arrangements made by the Board of Education at Birmingham, London, Oxford, Cambridge, and Harrogate The University of Birmingham is co-operating with the Board in the provision of courses in engineering science and electrical engineering at Birmingham and Oxford and in mining engineering at Birmingham. Prof. Burstall, Dean of the Faculty of Science, Profs. Batho, Cramp, Lea, Moss, J. S Haldane, MacGregor Morris, J. S Townsend, and other members of the University will deliver lectures and conduct demonstrations, tutorial classes, and discussions on teaching methods, and there are to be evening lectures by other eminent authorities in science and engineering The power house of the University as well as its departmental laboratories will be at the disposal of the instructors, and the University halls of residence will be used for the accommodation of those attending the courses At Oxford teachers attending the courses will be lodged in Oriel College At Cambridge a course in commercial subjects will be conducted at one of the colleges The courses in London will include building and surveying subjects and textile subjects The Board is to bear the cost of travelling to and from the places of instruction and to contribute a pound a week towards the cost of maintenance. Applications to attend must be sent to the Board before March 21.

Early Science at Oxford.

March 16, 1685–6. Dr. Garden of Aberdeen communicated his observations on the weather at Aberdeen in October, November and December 1685 Dr. Plot read a discourse concerning ye old Almanacks lately communicated by him, this will be printed in ye Doctor's History of Staffordshire

Mr. Thomas Wickam communicated the case of a Colt foaled with one of ye feet turned, ye heel standing forward, and ye toe backward, which being broken was set right, and grew together again so well, that ye Colt proved as serviceable a horse, as any of his condition thereabout

March 17, 1684–5.—With a letter from Mr Aston came ye Minutes of ye Dublin Society from December 1 to Feb. 23, 1684–5 inclusive Orders were given, that the thankes of our Society be returned for these Minutes, and that copies of Sir William Petty's *Supellex Philosophica*, and of Mr Brownlow's answers to ye Queries sent him concerning Lough-Neagh, be desired

A draught of Mr Beaumont's designe for writing ye History of ye Nature and Arts of the County of Somersett, was communicated

Dr Plot presented a Catalogue of some of ye most considerable Arcana and Desiderata in Chymistry as, followes —To reduce any of ye Metalls into a reall fluid To turne ye whole body of mercury into a clear Diaphanous water wetting ye hands To transmute one Metalline Species into another, especially ye baser, into gold and silver, either by projection, Cementation, Commixtion, or Digestion To make the liquor Alkahest, which will dissolve all bodies whatever, except its Compar, and what it is. To Sublime Antimony in it's own forme, black and striated To make a Menstruum, not corrosive, that shall perfectly dissolve all ye Metalls, particularly Gold and Silver To make urinous volatile Salt, or Spirit, from most Vegetables To make in good Quantity an Urinous Salt, and Spirit out of a Mineral with little cost To Mummiate an Animal entire without opening, or taking out the intestines, or giving to ye flesh any taste, colour, or smell To make glasse malleable To make many fragments of Diamonds, or other precious stones into one

March 18, 1683–4 —It was ordered that there be no election of Members into ye Philosophical Society, unless there be nine Members (at least) present, to make such election, which Article, with 13 others, agreed on March 11th, 1683–4, being entred in ye Journal Book, were subscribed, by Dr John Wallis, Savilian Professor of Geometry, Dr Ralph Bathurst, President of Trinity; Dr Beeston, Warden of New College, Dr Th Smith, Fellow of Magdalen; Dr Robert Plot, Professor of Chymistry, and Keeper of ye Musæum Ashmoleanum, Dr William Gibbons, St Johns, Edward Bernard, Savilian Professor of Astronomy, Jos Pulleyn of Magd Hall; John Caswell of Hart Hall, Th Piggot, of Wadham; S. Des-Masters, of Oriel; J Ballard and W. Musgrave, of New College, S Welsted, of Merton

We then passed to other Business Mr. Ballard informed ye Society, that ye Amianthus, on which his experiments were tried, was brought from Cyprus, by Dr Huntingdon, and communicated to us by Dr. Plot.

Manganese (a minerall, dug no where in England, but on Mendip-hills and used in ye purifying of glass) was not of itself affected by ye Magnet; but after above three hours calcination, it readily consented to it, as was shewn us by Dr. Plot. But Irish slate, calcined about four hours, could not be wrought on by ye Magnet; which gave Dr. Plot an occasion to draw up a discourse concerning severall Minerall waters, commonly thought to be Vitriol.

Societies and Academies.

LONDON.

Royal Society, March 5.—Sir Arthur **Schuster**: On the life statistics of fellows of the Royal Society. A revision and extension of a statistical inquiry made by Lieut.-Gen. R Strachey towards the end of last century Its principal results are: (1) The average age at election remained fairly constant between the years 1848, when the nominations for election were placed into the hands of the Council, and the end of the century, the average being 44·4 years There has been a decided increase since then, more especially in the last ten years, but some of this may have been due to war conditions. (2) The average age of fellows on January 1, 1923, was 60·9 years. (3) Their expectation of life is about 6 years greater than that recorded in the tables published in "Whitaker's Almanac" as applying to the entire population of England —G. I **Taylor** and Miss C. F **Elam** The plastic extension and fracture of aluminium crystals. In the early stages of the tests under direct tension the previous results are confirmed, and the nature of the distortion in the later stages is now proved to be due to slipping on the two crystal planes previously indicated After double slipping has begun, the rate of slip on the original slip-plane is usually greater than that on the new one The geometrical conditions with a shearing-stress parallel to the slip plane are such that the crystal is quite stable while the slip occurs on one plane, but as soon as double slipping occurs, it becomes far less stable, or even unstable. Therefore the specimen usually breaks before it has slipped far on the second plane, but never before the double slipping begins —A **Fage** An experimental study of the vibrations in the blades and shaft of an airscrew The sounds emitted were analysed with 4 Tucker hot-wire microphones used in conjunction with a four-valve amplifier. The sounds of rotation which arise from the rotation of the source-and-sink system associated with the pressure differences on the blades are composed of a large number of harmonics, having as fundamental a note of frequency equal to the product of the number of blades and the rotational speed The natural frequencies of flexural vibration were measured for four-blade shapes, the variables of design being width and geometrical pitch. The measured frequencies of the shaft vibrations agree very closely with the calculated results, except for a discrepancy of 8 per cent obtained on the heaviest airscrew —J. H **Vincent** and A L. **Beak**. Experiments on the effects of resistance in the oscillating circuit of a triode. The circuit employed is that previously used by Eccles and Vincent. In this the main oscillator consists of a condenser and coil in series, the coil being variably coupled to the grid coil which is in conductive connexion with a point between the condenser and main coil, the opposite point being joined to the negative end of the plate battery, these two points divide the main oscillating circuit into two branches, inductive and capacitive. With this apparatus the conditions were studied under which oscillations could be started and maintained, and the changes in frequency of oscillations and the simultaneous changes in the oscillating and mean plate currents, due to altering resistances in the inductive and capacitive branches of the oscillating circuit. The chief results support Eccles's control equation, but disagree with his formula for changes in frequency. G. H. **Hardy**. The lattice points of a circle. Proof of the fundamental identity in the problem of the circle by means of a singular integral the kernel of which is a theta-function, with an application to a theorem of J. E. Littlewood and A. Walfisz, published

recently in the Proceedings.—**H. M. Macdonald**: The transmission of electric waves around the earth's surface. The transmission of wireless signals to great distances and other phenomena associated with wireless telegraphy have been ascribed to the presence of a conducting layer in the upper atmosphere. Such a layer, if it were conducting in the ordinary sense, would act as a screen in respect of electrical effects having their origin external to the layer, and electrical disturbances set up in the space between the earth's surface and the conducting layer would subside very slowly. It appears natural, therefore, to assume that, if there is reflection from the upper atmosphere, there must also be radiation through it, to allow a steady state to be attained in a comparatively short time. The simplest hypothesis consistent with this is that the upper atmosphere differs from the lower atmosphere in respect of the constants involved in the propagation of electrical effects, namely, the specific inductive capacity and the magnetic permeability. On this hypothesis the condition that a steady state of electrical oscillation can be set up in the lower atmosphere in a comparatively short time is investigated. Taking an ideal case, the condition is that the ratio of specific inductive capacities is approximately equal to the ratio of magnetic permeabilities.—**R. M. Wilmotte**: On the field of force near the neutral point produced by two equal coaxial coils with special reference to the Campbell standard of mutual inductance. The accuracy of any apparatus depending on the mutual inductance between two coils and another coil situated at the neutral circle formed by the magnetic field of the first two coils depends largely on the variation of the magnetic force near the neutral circle. An expression in terms of the magnetic forces produced by a circular current is obtained for the variation of the mutual inductance due to a small displacement from the neutral circle of a single turn of wire acting as the secondary to two co-axial single-layer coils.—**W. R. Dean**: On the theory of elastic stability. After Hooke's Law has been extended, two methods are available. The three conditions for the equilibrium of an elementary volume may be written down, correctly to the second order, by considering the forces acting upon it, or the strain energy may be calculated to the third order, and the equations obtained by variation. With a cylindrical shell the energy method is shorter. The equations refer in the first instance to the displacements of any point of the shell. To reduce them to equations connecting the displacements of points of the middle surface only, the displacements of any point are expanded in series of the distance of this point from the middle surface, and the boundary conditions at the faces are used.—**R. A. Frazer**: On the motion of circular cylinders in a viscous fluid. The paper is restricted to two-dimensional flow, and deals primarily with the motion of circular cylinders in fluids of great viscosity, inertia terms being neglected. The flow due to a stationary cylinder immersed in a uniform infinite river is treated as the limiting case of flow between two concentric boundaries, the stream being uniform over the outer, and stationary over the inner. The essential elements for a solution are obtained with arbitrary velocity distributions specified over any two mutually external circular cylinders. The stream-function is completed for the case where the cylinders are in steady rotation. Another type of motion investigated is where two spinning cylinders are rotated as a "planetary" system about a particular "focus." The cases examined include "planetary" systems, problems of contact, and the combined rotation and translation of a cylinder in proximity to a wall.

Geological Society, January 21.—**Léon W. Collet**. The latest ideas on the formation of the Alpine range. In 1905 Prof. E. Argand determined in the Pennine Alps the existence of six great recumbent folds or nappes. On the base of Argand's results, Dr. R. Staub found in the north-eastern part of the Swiss Alps the same tectonic elements, covered by six higher nappes belonging more to the type of the "thrust-masses" of the North-Western Highlands of Scotland than to the type of the recumbent folds of the Pennine Alps. This new series of nappes has been named by Staub the Austrides, for they form the main part of the Austrian Alps. Prof. L. Kober's discovery of a window or horizontal cut, due to erosion, in the nappes of the Austrides, revealing deeper nappes belonging to the Pennine series, shows that the nappes of the Austrides have been thrust over the Pennine nappes in the Austrian Alps, just as in the north-eastern part of Switzerland. Co-ordination of the work by Austrian and Swiss geologists was accomplished at the end of last year by Dr. Staub. Wegener's ideas on the drifting of continental masses are employed to explain the movement of the hinterland towards the foreland of the geosyncline. Foreland and hinterland constitute the boundaries of the great Alpine geosyncline; together they recall the two jaws of a vice. Prof. Argand has shown that the nappes of the Austrides belong to the hinterland; that is, to Africa or Gondwanaland. Therefore the Austrides, with the Préalpes, represent a small part of Africa resting on Europe or Eurasia.

February 4.—**A. Heard**. The petrology of the district between Nevin and Clynnogfawr (Carnarvonshire). Drift obscures most of the valleys, and conceals the greater part of the areas underlain by unaltered shales. Most of the sedimentary rocks consist of dark purplish-grey shales of *Didymograptus-bifidusage*, together with their metamorphosed representatives. In the north-western part of the area unfossiliferous pale-grey shales containing numerous ashy and fine-grained gritty bands are present. A large proportion of the exposed rocks consists of an igneous complex of post-Lower Arenig—pre-Old Red Sandstone age. The intrusive rocks present many petrological variations, including numerous different types of granite and quartz-porphyries, granophyres, porphyries of intermediate composition, and basic rocks. The "banding" of the constituents of the coarser-grained intrusive masses is peculiar. Neither hybridism nor any apparent chilling is exhibited at the junction of adjacent "bands," and the uppermost band invariably consists of the most basic rock.

CAMBRIDGE.

Philosophical Society, February 2.—**L. F. Curtiss**: A preliminary note on a direct determination of the distribution of intensity in the natural β-ray spectrum of radium-B and radium-C. The number of electrons in each small range of velocity in the β-ray spectrum of radium-B and -C is measured by observing the charge communicated to a Faraday cylinder. The advantage is that full weight is given to every portion of the spectrum, and errors due to the variation of ionisation with velocity are avoided. Since in this method it was unnecessary to have any covering over the mouth of the Faraday cylinder, it was possible to investigate very low velocities, and an interesting emission was found about 250 $H\rho$.—**C. D. Ellis and W. A. Wooster**: Note on the heating effect of the γ-rays from radium-B and radium-C. The chief difficulty in this determination is due to the presence of the α-rays from radium-C; they produced a heating

one hundred times as great as that due to the γ-rays. This was overcome by an automatic compensation method. The rise in temperature was measured by means of thermocouples and the equivalent amount of heat found by calibration experiments with heating coils. The amount of radium-B + C in equilibrium with 1 gram of radium emits 8·1 cal./hour in the form of γ-rays.—C. D. **Ellis** and M. **Bowman-Manifold**: The interpretation of β-ray absorption curves. The approximate exponential absorption curves are due to the initial heterogeneity of the radiation. The absorption curve of a continuous spectrum can be explained by the superposition of the linear absorptions of the β-rays contained in each small range of velocities. The form of the continuous spectrum is simply related to the second differential coefficient of the absorption curve.—D. **Stockdale**: A thermostat for high temperatures. The instrument is designed to control the heating of electrical resistance furnaces. The electro-motive force given by a thermocouple, the hot junction of which is placed in the furnace, is balanced against the fall of potential along a wire. If the system is not in equilibrium, a galvanometer is deflected, and a boom carried by this galvanometer touches a wheel, an electrical circuit is closed and a relay is actuated in such a way that the current heating the furnace is altered until equilibrium is again established. It was fairly easy to maintain any temperature up to 1000° C. with a fluctuation of not more than 3° C.—W. G. **Palmer**. A method of finding the composition of adsorption films of mixed gases. The gas in an adsorption layer between two fine metallic filaments in mechanical contact can be removed, and metallic contact established by applying to the junction an electric stress, the value of which is characteristic of a particular gas and adsorbing material. When a bare surface first comes into contact with a mixture of gases, the composition of the initial film formed is directly calculable from the partial pressures and molecular weights of the gases. This film will in general change in composition to an equilibrium value. The composition of this final film is given by plotting the relation between electric stress required to remove the initial film and the composition of this film.—A. P. **Cary** and E. K. **Rideal**. The spreading of oils and fats on water surfaces.—W. **Saddler**. Triple binary forms; the complete system for a single (1, 1, 1) form with its geometrical interpretation.—W. **Burnside**: On the phrase "equally probable."

Dublin

Royal Dublin Society, January 27.—G. **Brownlee**: The interpretation of certain empirical standards in their application to Irish butter. An investigation of a large number of samples of butter, collected from various creameries by the inspectors of the Department of Agriculture and Technical Instruction of the Irish Free State, has shown that, during the months of November, December, and January, the Reichert-Wolny number of Irish butter is usually below the value 24, which is generally taken as the lower limit for pure butter. This is in agreement with the results of a previous investigation carried out some years ago. The values obtained for the other numbers used for defining the properties of butter also frequently fell outside the limits generally assumed to be applicable to pure butter.—E. A. **Werner**: The decomposition of certain amino acids by alkaline hypobromite.

Rome.

Royal Academy of the Lincei, November 2.—F. **Zambonini** and G. **Carobbi**: Double sulphates of rare earth and alkali metals. I. Double sulphates of lanthanum and potassium. Systematic study of the ternary systems composed of these two sulphates and water shows the existence of six compounds containing $La_2(SO_4)_3$, K_2SO_4 and H_2O in the molecular proportions, 1 : 5·2, 1 : 4·5 : 2, 1 : 4 : 1, 1 : 3 : 0, 2 . 3 8, and 1 : 1 : 2 respectively.—Ferruccio **Zambonini** and V. **Caglioti**: Double sulphates of rare earth and alkali metals. II. Double sulphates of neodymium and potassium. In this case the molecular proportions of the components of the double salts are 1 : 5 : 2, 1 : 4 : 2, 1 · 4 · 1, 1 3 : 2, 2 : 3 · 8, and 1 : 1 : 2.—V. **Ronchi**: An interferential method for the direct determination of the constants and aberrations of divergent optical systems. The method of combination fringes previously applied to convergent optical systems is simplified by the use of an auto-collimating arrangement as so to require only a single grating.—Dino **Bigiavi**: Action of nitrous acid on the azophenols. With nitrous acid, *p* : *p*′-dihydroxyazophenol yields a dinitroazophenol, and is also partly oxidised to *p*-nitrophenol, the diazo-group undergoing rupture, benzeneazo-α-naphthol also appears to suffer oxidation, whilst other azo-phenols yield diazonium salts, together with products not yet investigated.—G. **Carobbi**: Double nitrates of metals of the cerium group with copper and with cadmium. Compounds of the type $2X(NO_3)_3$, $3Ca(NO_3)_2$, $24H_2O$, where X represents Nd, Pr, Sm, and of the type $2X(NO_3)_3$, $3Cd(NO_3)_2$, $24H_2O$, where X represents La, Ce, Nd, are described, by means of the double nitrates formed with copper, lanthanum may be separated from præseodymium.—Gustavo **Cumin**: Geological data on the Istrian mountain region. II. Tectonics and morphology.—Marcello **Boldrini**: Internal and external measurements of certain long bones in man and in woman. II. Measurement of the intensity of the secondary sexual characters.—Cesare **Artom**: Numerical disproportion of the sexes in *Gambusia holbrooki* (Grd.) analysed as to its manifold causes. For most generations of the top-minnow, the numerical relation of the sexes at birth is 1 . 1, but in one autumnal generation a predominance of females was observed.—Boldrino **Boldrini**: Biological reactions observed in the blood serum of woman during and after the lacteal decline. II. Demonstration of an agglutinin of the globules of human milk.—Primo **Dorello**: Contribution to the knowledge of the biology of the nemasperms in the pulmonated gasteropods.—Carlo **Jucci**: Bivoltinism and parthenogenesis in silkworms (*Bombyx mori*).—Sergio **Sergi**: Myorabdotic cellular groups in the cervical region of the spinal medulla of the chimpanzee.

November 16, 1924.—Luigi **Bianchi**. A class of pairs of stratifiable rectilinear congruences.—G. **Bruni** and G. R. **Levi**: Solid solutions between compounds of elements of different valencies. The formation of solid solutions of lithium and magnesium fluorides, previously indicated by the results of thermal analysis of the system, is confirmed by X-ray examination. The substitution of magnesium fluoride molecules for a corresponding number of double lithium fluoride molecules produces neither an appreciable alteration in the lithium fluoride lattice nor the appearance of new lines in the photograms.—F. **Zambonini** and V. **Caglioti**: Double sulphates of the rare earth and alkali metals. II. Neodymium and potassium sulphates. Descriptions are given of the various double sulphates previously found.—Federico **Sacco**: An opened nummulite.—J. **Pérès**: Transformations which maintain the composition.—Bruto **Caldonazzo**: Differential geometry of surfaces of hydrodynamic interest.—Umberto

Crudeli: Rhombic systems with uniform rotation in electronic dynamics.—Paolo **Stranco**: Theory of Einstein fields with axial symmetry.—Guido Horn **d'Arturo**: Flying shadows visible during solar eclipses.—Rita **Brunetti**: Fine structure of the helium line 5876 Å.U.—G. **Carobbi**: Double chromates of rare earth and alkali metals I. Lanthanum and potassium chromates. Investigation of the isotherm for 25° reveals the existence of double salts containing $La(CrO_4)_3$, K_2CrO_4, and H_2O in the molecular proportions, 1 : 1 : 2, 1 3 : 2, 1 : 4 : 2, 1 . 4·5 · 2, and 1 : 5 . 2, these corresponding with the proportions found in the double sulphates of the same metals, excepting that, in the latter case, the 1 . 3-compound is anhydrous, and the 1 · 4-salt monohydrated.—Roberto **Savelli**: Genetic value of the process of fonolysis of gametes.—Marcello **Boldrini**: Internal and external measurements of certain long bones in man and in woman III The volume of the medullary cavity and hematopoiesis in the two sexes.—A **Clementi**: Adaptation of tadpoles to the chemico-physical conditions of the surrounding medium.—Boldrino **Boldrini** Biological reactions observed in the blood serum of woman during and after the lacteal decline. III. Demonstration of the existence of proteolytic enzymes capable of hydrolysing the proteins of human milk.—Carlo **Jucci**: Varying prochivity to parthenogenesis in different races of silkworms (*Bombyx mori*) and its probable correlation with the varying tendency to bivoltinism.—Sergio **Sergi**: Myorabdotic cellular groups in the thoracic region and the limits between the thoracic and lumbar regions in the spinal medulla of the chimpanzee

VIENNA.

Academy of Sciences, January 8.—K **Umrath** The conduction of excitation in the leaf of *Mimosa pudica*. The velocity of conduction is discontinuous and is dependent on the nature and strength of the stimulus The separate stages may be ascribed to separate conducting systems The velocity is less in the leaflets than in the secondary leaf-stalk, and less in them than in the primary leaf-stalk The system of greatest velocity is in the chief bundles.—T. **Ciuropajlowicz**: Two proofs of Fermat's great theorem.—I. **Waldmann**: Report on the geological survey of Moravian territory between Eggenburg, Pernegg, and Theras A series of orthogneiss intrusions and strata of rocks of sedimentary origin.—G. **Weissenberger**, F **Schuster**, and K **Wojnoff**. Molecular compounds of the phenols VI. The behaviour of hydrated cresols and allied compounds.—L. **Moser** and E. **Reitschl**: The determination and separation of the rare metals from other metals. VI. Determination of the solubility and sensitiveness of complex compounds of cæsium and rubidium and their application in analysis For quantitative analysis only the chloroplatinate, perchlorate, and bitartrate come into consideration. A quantitative separation was not attained There is no special cæsium or rubidium reagent, only sensitiveness is decisive. The best indication is given by silico-molybdic acid, by which potassium is not precipitated. Phosphotungstic acid is still more sensitive, but precipitates potassium also

Official Publications Received.

University of London: University College. Report of the University College Committee (February 1924–February 1925), with Financial Statements (for the Session 1923-24), and other Documents, for Presentation to the Senate. Pp. 101. (London.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1924. Pp. ix+206. (Washington: Government Printing Office.) 45 cents.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol 13, Part 3: On the Phenomena of Sex Transition in *Arisæma japonica* Bl. By Tokujiro Maekawa. Pp. 217-306 +1 plate. Vol. 15, Part 2: Das Urogenitalsystem der Urodelen Von Samuro Yamagiwa. Pp. 87-82+4 Tafeln (Sapporo.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No 276: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Honolulu, Hawaii, in 1921 and 1922. By Daniel L. Hazard Pp 100+4 charts. Serial No. 282: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Sitka, Alaska, in 1921 and 1922 By Daniel L. Hazard. Pp. 100+10 charts. (Washington. Government Printing Office.) 25 cents each.

Ceylon Administration Reports for 1923 Department of Agriculture: Report of the Director of Agriculture for 1923. Pp D54 (Peradeniya.)

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Official Year 1923-24. Pp 48. (Madras Government Press.) 6 annas

Memoirs of the Geological Survey of India Vol 48, Part 2: The Geology of parts of the Persian Provinces of Fars, Kirman and Laristan. By Dr. Guy E. Pilgrim. Pp iv+116+xiii+plates 11-16 (Calcutta: Government of India Central Publication Branch.) 3.12 rupees, 6s. 3d

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia Verhandelingen No. 8. Het Klimaat van Nederlandsch-Indie (The Climate of the Netherlands Indies) Deel 1 (Vol 1), Algemeene Hoofdstukken (General Chapters), Aflevering 7 (Part 7) With English Summaries. Pp. iv+417-497+199-248 (Batavia.)

Forest Research Institute, Dehra Dun, (U.P.), India: Economic Branch. Testing of Raw Materials. Scheme of Operation No. 1 for Project No. 5, Paper Pulp Section By W. Raitt Pp iii+10. (Calcutta: Government of India Central Publication Branch.) 5 annas; 6d.

Publications of the South African Institute for Medical Research. Edited by Dr. W Watkins-Pitchford. No 18 An Investigation into the Significance of Localised and more or less Persistent Râles in the Marginal Areas of the Lungs of apparently Healthy Natives By Dr W. Watkins-Pitchford and Dr. Peter Allan. Pp 35 (Johannesburg.) 5s

Calendario della Basilica Pontificia del Santissimo Rosario in Valle di Pompei pel 1925 Pp 256 (Valle di Pompei.)

First Greenwich Catalogue of Stars for 1925·0 Catalogue of 2043 Stars from Observations with the Transit Circle made at the Royal Observatory, Greenwich, during the Years 1915-1921, under the Direction of Sir Frank Watson Dyson. Pp xix+68 (London: H.M. Stationery Office.) 20s. net.

Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the Year 1922, under the Direction of Sir Frank Dyson Pp. 8+A57+B4+C2+D9x+D51+E5+Exxi+E84+20 (London: H.M. Stationery Office). 35s net.

Publikationer fra det Danske Meteorologiske Institut Aarbøger Isforholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1924 Pp 38+5 *maps*. (København: G. E. C. Gad.)

The Marine Biological Station at Port Erin (Isle of Man). Supplement to Thirty-eighth Annual Report. List of the Published Works of the late Sir William A. Herdman, C.B.E., F.R.S., D.Sc., etc. Arranged by E. Catherine Herdman Pp 25 (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.)

Journal of the Marine Biological Association of the United Kingdom New Series, Vol. 13, No. 3, March Pp 531-754. (Plymouth.) 9s net.

Journal of the Chemical Society, containing Papers communicated to the Society. 1925, Vol 127, February Pp ix+viii+305-498. (London: Gurney and Jackson.)

Journal of the Chemical Society Supplementary Number, containing Title-pages, Contents and Indexes 1924, Vol. 125 Pp 2699-2796+xxx+4. (London: Gurney and Jackson.)

Abstracts of Chemical Papers issued by the Bureau of Chemical Abstracts A: Pure Chemistry. Supplementary Number, containing Title-pages and Indexes. 1924, Vol 126 Pp ii+877-ii.1304+20. (London: Gurney and Jackson.)

Transactions and Proceedings of the Perthshire Society of Natural Science Vol 6, Part 1, 1923-24 Pp. 15+xv+5 plates. (Perth.)

U.S. Department of the Interior Annual Report of the Commissioner of Education to the Secretary of the Interior for the Fiscal Year ended June 30, 1924 Pp iii+82 (Washington: Government Printing Office.) 5 cents.

Diary of Societies.

SATURDAY, MARCH 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (III.)

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at Manchester College of Technology), at 4.—G. Edgington. Oil-Sand Cores

SUNDAY, MARCH 15.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Criterion Theatre, Piccadilly Circus, W.), at 3.—Dr. H. M. Telling, Dr. M. Thomson, Dr. Jane L. Hawthorne, Dr. Marie Stopes, and others: Why Doctors Disagree about Birth Control.

MONDAY, MARCH 16.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—R. D. Oldham: The Portolan Maps of the Rhône Delta.

INSTITUTION OF AUTOMOBILE ENGINEERS (Loughborough Graduates' Meeting) (at Loughborough College), at 7.—E. R. Caffyn: A Few Features of Early Car Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Informal Discussion on The Application of Electricity on Board Ship.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—J. A. Oliver: Industrial Electric Vehicles.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—F. G. Woollard: Some Notes on British Methods of Continuous Production.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—F. R. Hiorns: The Corporate Spirit in Architecture.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—H. G. Collingwood: The Nature and Aims of a Philosophy of History.

MEDICAL SOCIETY OF LONDON, at 8.—*Sir Bernard Spilsbury*: Wounds and other Injuries (Lettsomian Lectures) (III.).

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Dr. H. C. Cameron: John Locke, the Philosopher (1690), on the Upbringing of Children.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court, S.W.).

TUESDAY, MARCH 17.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. A. Ryle: The Study of Gastric Function in Health and Disease (Goulstonian Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. E. N. da C. Andrade: The Evolution of the Scientific Instrument (II.).

ROYAL STATISTICAL SOCIETY (Royal Society of Arts), at 5.15.—C. W. Hurcomb: Official Railway Statistics in Great Britain.

MINERALOGICAL SOCIETY OF LONDON (at Geological Society), at 5.30.—S. Tomkeieff: The Structure of Aragonite.—E. D. Mountain: Potash-oligoclase from Mt. Erebus, South Victoria Land, and Anorthoclase from Mt. Kenya, E. Africa.—Dr. A. Brammall: Further Notes on the Association of Lime with other Oxides of RO-type in Minerals.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions made to the Society's Menagerie during the month of February 1925.—Rev. F. C. R. Jourdain: A Study on Parasitism in the Cuckoo.—C. R. Narayana Rao and B. S. Ramanna: A New Genus of the Family Eugystomatidæ (Batrachia).—Dr. Nellie B. Eales: External Characters, Skin, and Temporal Gland of a Fœtal African Elephant.—F. F. Laidlaw: Description of a New Genus and Two New Species of Dragon flies (Odonata) belonging to the Family Comphidæ from Tropical Asia.—Rev. Dr. F. J. Wyeth: The Development and Neuromery of the Mid-Brain and Hind-Brain in *Sphenodon punctatus*.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—A. C. Hardy: Motor Passenger Vessels.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Students' Section) (at Leeds University), at 7.—W. R. T. Skinner and G. E. Barrett: High-pressure and High-temperature Steam.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Col. T. F. Purves: The Post Office and Automatic Telephones.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—H. T. Tizard: Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.30.—(Annual Meeting of Scientific and Technical Group.)—Dr. T. Slater Price: Some Modern Views on the Sensitivity of Emulsions.

HULL CHEMICAL ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—N. Simkin: Some Aspects of Low-Temperature Carbonisation.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Annual Meeting.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton).

SOCIETY OF DYERS AND COLOURISTS (Leeds Junior Branch) (Annual Meeting) (at Leeds).—Prof. A. G. Perkin: Paper.

WEDNESDAY, MARCH 18.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with the Chemical Engineering Group) (at 39 Elmbank Crescent, Glasgow), at 7.—Prof. J. W. Hinchley: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Sheffield University), at 7.30.—G. F. Jones: Some Considerations in the Design, Manufacture, and Testing of Broadcasting Wireless Receiving Apparatus.

INSTITUTE OF METALS (North-East Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—A. G. Lobley: Electric Furnaces.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Sir Napier Shaw and H. Fahmy: The Energy of Saturated Air in a Natural Environment.—C. K. M. Douglas: The Relation between the Source of the Air and the Upper Air Temperature up to the Base of the Stratosphere.—A. H. R. Goldie: Waves at an approximately Horizontal Surface of Discontinuity in the Atmosphere.

ROYAL SOCIETY OF ARTS, at 8.—C. N. Friese-Greene: Colour Cinematography.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates' Meeting) (at Chamber of Commerce, Birmingham).

SOCIETY OF GLASS TECHNOLOGY (at Newcastle-upon-Tyne).

THURSDAY, MARCH 19.

ROYAL SOCIETY, at 4.30.—Sir William Hardy and Miss Ida Bircumshaw: Boundary Lubrication. Plane Surfaces and the Limitations of Amontons' Law (Bakerian Lecture).

LINNEAN SOCIETY OF LONDON, at 5.—A. S. Hirst: Parasitic Mites found on Lizards.—W. R. B. Oliver: Biogeographical Relations of the New Zealand Region.—Mrs. M. Roach: A Study of the Physiology of certain Soil-Algæ in Pure Culture.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. J. Ryle: The Study of Gastric Function in Health and Disease (Goulstonian Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. Leonard Hill: The Biological Action of Light (II.).

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Capt. F. Tymms: Practical Navigation of Aircraft.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Councillor B. T. Cooke: What the Miners' Welfare Fund is doing for Children and Young People in Mining Communities.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Presentation of the Faraday Medal to Sir J. J. Thomson.—S. Evershed: Permanent Magnets in Theory and Practice.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.

INSTITUTE OF CHEMISTRY (Bristol Section) (at Bristol University), at 7.30.—Annual Meeting.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Bolbec Hall, Newcastle-upon-Tyne), at 7.30.—B. J. Ives: Seaworthiness.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduates' Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—E. A. Harroway: British and Foreign Shipyard Practice.

CHEMICAL SOCIETY, at 8.—D. H. Bangham and J. Stafford: The "Activation" of Graphite as a Sorbent of Oxygen.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section, jointly with the Society of Chemical Industry (Edinburgh and East of Scotland Section)) (at North British Station Hotel, Edinburgh), at 8.—Informal Meeting.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at Royal Army Medical College, Grosvenor Road, S.W.), at 8.15.—Demonstrations by Drs. D. Adams, A. W. Grace, E. Hindle and J. T. Duncan, H. B. Newham, A. S. Burgess, Col. M. Perry, Drs. H. Seidelin, A. C. Stevenson, J. Gordon Thomson, C. M. Wenyon, and Mr. A. L. Sheather, and Prof. Warrington Yorke.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—H. P. Hird: Further Researches on Coal Combustion.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—F. J. Chittenden: Experiments with Fruit Trees.

FRIDAY, MARCH 20.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 5.—Dr. J. Brownlee: The Present Tendencies of Population in Great Britain in respect of Quantity and Quality.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Surgical Anatomy of the Middle Ear.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—F. C. Tilney: Address.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (Annual General Meeting) (at Technical College, Cardiff), at 7.30.—G. H. Clegg: Chairman's Address.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. H. Hole: Modern Transport.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—Open Discussion.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. W. McBain: Soaps and the Theory of Colloids.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester).—Dr. F. M. Rowe, A. C. Burns, and J. S. H. Davies: A New Reaction with certain Diazo Sulphonates derived from β-naphthol-1-Sulphonic Acid.

SATURDAY, MARCH 21.

BRITISH PSYCHOLOGICAL SOCIETY (at Bedford College, Regent's Park), at 3.—R. H. Thouless: The Physics of the Psychogalvanic Reflex Phenomenon.—Rev. R. C. McCarthy: The "Determining Tendency" and Conation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (IV.).

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch: Junior Section) (at Manchester College of Technology), at 7.—H. Stead: Plate Moulding and the Patternmaker.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY.—Dr. H. M. Cade: The Germ Theory of Disease (Pathogenic Bacteria).

PHYSIOLOGICAL SOCIETY (Annual General Meeting) (at University College).

PUBLIC LECTURES.

SATURDAY, MARCH 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. R. L. Sherlock: Man as a Geological Agent.

TUESDAY, MARCH 17.

UNIVERSITY COLLEGE, at 5.30.—C. D. Forde: The Megalithic Monuments of Brittany.—Prof. A. C. Seward: The Cretaceous Vegetation of Greenland. (Succeeding Lectures on March 20, 24.)

CASTLE MUSEUM, NORWICH, at 8.—Prof. Adshead: Housing after Slum Clearance (Chadwick Lecture).

UNIVERSITY, LEEDS, at 8.—E. Percival: The Freshwater Zoology of Yorkshire.

WEDNESDAY, MARCH 18.

KING'S COLLEGE, at 5.30.—Prof. J. D. Wilson: Education and Industrial Democracy.

FRIDAY, MARCH 20.

UNIVERSITY COLLEGE, CARDIFF, at 7.—Dr. W. M. Feldman: Ante-Natal Child Physiology and Hygiene (Chadwick Lecture).

SATURDAY, MARCH 21.

UNIVERSITY COLLEGE, at 3.—Dr. F. M. Feldman: Post-Natal Child Physiology and Hygiene (Chadwick Lecture).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. Hazzledine Warren: Who were the First Men?



SATURDAY, MARCH 21, 1925.

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 2890, VOL. 115]

The Fate of the Energy of the Universe: a Tangled Skein.

THE two outstanding conceptions of the nineteenth century were undoubtedly the principle of the conservation of energy, and the closely allied and supplementary principle of the dissipation of energy. Energy was conserved amid all its protean changes, but at each change its availability was lessened. On these two foundations rests the whole structure of thermodynamics. Neither of these conceptions stands exactly where it did, though a good deal of strong evidence will be required to shake the former. In a remarkable paper, read before the Cambridge Philosophical Society only a few months before his death, Prof. Liveing, at the age of ninety-five, threw out a challenge to the latter. Looking back over an active career covering in point of time almost the whole of what we now call science, the veteran felt that the dissipation of energy was not the whole truth. This universe could not be destined to subside into a tideless sea of unavailable energy, moved by no currents, stirred by no ripple, changeless and unchangeable. Somewhere, by some unknown process, the degraded energy must be undergoing a process of renewal and reintegration, to play its part once more in the physical world.

It is interesting to find from the report of a recent address given to the Radio Society by its distinguished president, Sir Oliver Lodge, that similar conclusions have been reached by still another scientific worker of long and ripe experience. In view of his more than youthful energy and freshness of outlook, it would be absurd to call Sir Oliver a veteran, but it cannot be denied that he has had a longer experience of scientific thought than most. His suggestions are always worthy of consideration, and, moreover, are always made in such concrete and positive form as to leave no doubt as to what they are.

Of the earlier parts of Sir Oliver's address it is not necessary to give any account. Towards the end of his discourse, however, after reviewing the principal facts of atomic structure, of photo-electricity, of thermionics, and of radio-telegraphy, he leaves the beaten track of accepted theory and experiment and launches forth on new and dangerous seas of thought. For Sir Oliver Lodge is not content with expressing a belief in the reintegration of energy; he also has a definite theory, or at least the beginnings of a theory, as to how this reintegration is accomplished.

Sir Oliver is at the present time the doughtiest of the champions of the ether, as against the mathematicians of the relativistic school, who, if they do not actually deny its existence, have at least no use for such a medium; and it may be that in times to come this

insistence that a basis for the universe must be sought in a physical medium rather than in a set of equations will be regarded as not the least of his contributions to physics. To him the electron and the proton are local modifications of this all-embracing fluid; knots, or, perhaps, bubbles in the ether, a conception already made familiar by Sir Joseph Larmor. Thus matter, which is built up of protons and electrons, is just a manifestation of local peculiarities in the ether. The protons and electrons attract each other. "A little friction will disturb and separate them," Sir Oliver reminds us, "but they will get together again as soon as they can. Whenever they approach each other, they radiate. The more violent the clash, the more vigorous the radiation. Do they ever actually inextricably clash, and annihilate each other? It is not known that they ever do, there seems to be something which keeps them apart Things on earth seem too staid and quiet to allow of an actual destructive clash, or anything like mutual extermination But the operation is conceivable, and as we now know that some of the stars have a temperature to be reckoned in millions of degrees, strange and violent things may be going on there."

"We can," continues Sir Oliver, "at least contemplate the process and ask what would happen if they did; the answer is clear enough The two opposite charges would vanish in a puff of radiation; all that would persist of them would be their energy; there is no destroying that. The energy would no longer be localised in specks of matter, it would now wholly and obviously belong to the ether" Sir Oliver thus accepts the transformation of matter into radiant energy, which has been postulated by Jeans and others to account for the intense radiation from the stars; and further suggests that the energy for this colossal output of radiation is supplied by the liberation of the potential energy stored up in the knots or strains in the ether which constitute electrical charges. "Dr. Jeans tells us that the sun loses 4,000,000 tons of matter every second. That is the rate at which it is radiating ether waves—converting matter into ether energy and radiating it away." It may be that Sir Oliver's theory from one point of view adds nothing to Einstein's postulate of the equivalence of matter and energy. It does, however, provide a conceivable picture of the method of transformation, and to the physicist who thinks in pictures rather than in formulæ, this is no small boon.

The crux of the address, however, lies in the succeeding paragraph. "What I want to ask is," says Sir Oliver, "is there any reciprocity about this process? Matter can turn into radiation. Can radiation turn into matter? I surmise that it can, but not under ordinary conditions. I guess that the waste radiation careering through space from all the innumerable suns and through innumerable millenniums must have some result. I imagine them to be generating matter in the far depths of space; which matter can then by gravitation fall together and reproduce or keep in maintenance the whole material cosmos. I see no ultimate dissipation of energy in the universe. I see energy passing from matter to ether and back again."

These singular speculations, which we have recorded so far as possible in the author's own words, open up interesting vistas. If, as Sir Oliver suggests, these knots possess the property of re-forming themselves when untied, they are indeed ethereal strains wafting to this tangled skein of which we form a part, the promise of an immortality not only in the future but also in the past. But, as Sir Oliver himself reminds us, speculation is comparatively useless unless it can be tested, and we are sure that he would not have published this unless he had glimpsed some way in which it might be put to the test of experiment. An address to a popular audience did not, perhaps, afford a suitable occasion for the fuller exposition of these matters, which we hope he will shortly give us. In the meantime we may be grateful to Sir Oliver Lodge for his challenge to lift our eyes to the wider horizons. It is good to be reminded, in this age of scientific progress, how little we really know.

Population and Evolution.

Malthus and his Work. By Dr. James Bonar. Second edition. Pp. viii+438. (London: G. Allen and Unwin, Ltd., 1924.) 12*s.* 6*d.* net.

"IN October 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on from long continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed."

In these words, Darwin in the well-known autobiographical sketch acknowledged his debt to Malthus. It is also well known that Wallace made a similar acknowledgment. In a letter to Prof. Newton he referred to the matter as follows:

"The most interesting coincidence in the matter, I think, is, that I, as well as Darwin, was led to the theory itself through Malthus—in my case it was his elaborate account of the action of 'preventive checks' in keeping down the population of savage races to a tolerably fixed but scanty number. This had strongly impressed me, and it suddenly flashed upon me that all animals are necessarily thus kept down—'the struggle for existence'—while variations, of which I

was always thinking, must necessarily often be beneficial, and would cause those varieties to increase while the injurious variations diminished."

On another occasion, Wallace commented upon the fact that, whereas in his own case it was the recollection of his previous reading of Malthus, which came to him while puzzling over the problems of organic life during an attack of fever when on a visit to the East, Darwin chanced to read Malthus when he had for some time already had the problem of evolution in mind.

This difference is of no moment; the profoundly interesting fact is that both the authors of the famous papers read to the Linnean Society on July 1, 1858, afterwards acknowledged their debt to Malthus. It is also an example of the fame of Malthus's book that two specialists in quite another field should have read the book more than forty years after the publication of the first edition. We may guess, however, that they did not pick up the book wholly by chance. They probably had some previous idea as to its contents, and were led to study it because they suspected, even if only half consciously, that the theme had some reference to their own studies. This turned out to be very much the case. Malthus was not a biologist or a naturalist, though it is perhaps worth noting that his father was an amateur botanist and specifically disposed in his will of a box of plants given to him by Rousseau. By training a mathematician (he was ninth wrangler in 1788), Malthus was by taste interested in social problems. At Cambridge he was "remarked for talking of what actually exists in nature or may be put to real practical use" rather than for abstract speculations. When, therefore, after leaving Cambridge, friendly discussions took place between him and his father, who looked kindly upon Jacobinism, the views of Godwin and prospects of "perfectibility," it is not surprising that the younger man "threw little stones" into his father's garden. The son saw practical difficulties in the way of "improving society" and concentrated his attention upon the difficulties connected with population as among the most serious.

Malthus was thus led to put his views in the form of an essay, which was much expanded in later editions. In the opening chapter, stress is laid upon "the prolific nature of plants or animals," to which there is no bound "but what is made by the crowding and interfering with each other's means of subsistence." Malthus, however, was not interested in plants or animals other than man, and it is with the consequences of man's power of multiplication that he is concerned. This hint, nevertheless, was of the utmost value to Darwin. "A struggle for existence inevitably follows from the high rate at which all organic beings tend to increase," he says in the famous third chapter of the "Origin of Species." The very phrase "struggle for existence" was, it is interesting to note, used by Malthus himself. After some further amplification of the idea of the struggle for existence, Darwin goes on to say that "it is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms."

The influence of Malthus upon Darwin and Wallace is not merely a matter of historical interest. It reminds us of the fact that many social problems are, at the bottom, biological problems. There is nowadays a strong revival of interest in the question of population, and we may distinguish between problems connected with the quantity and problems connected with the quality of population. Upon both of these problems biologists have much of value to contribute. Indeed, for the solution of many problems of pressing practical importance, further biological research is urgently required. We know little, for example, regarding the comparative fecundity of different races and regarding the influence of variations in the food supply upon the fecundity of members of the same race. There are hints that crowding has an important, though an obscure, influence upon the power of multiplication. Upon these and other important points bearing upon the quantity of population, we await progress in biological inquiry. The problems regarding the quality of population, which were formerly much neglected, are now receiving attention and biologists are "throwing little stones" into the gardens of our modern counterparts of the old believers in "perfectibility." They could, however, take far more effective aim if they were furnished with more extensive and accurate data such as further research alone can provide.

The widespread interest in population which Malthus aroused gradually died away. To those concerned with social economics it came to seem a remote problem, and biologists had not advanced the study of inheritance far enough to be able to contribute much that was of value. Interest has now revived; the War has made certain aspects of pressing importance, and we may be sure that this time the problem has come to stay. Thus a warm welcome is ensured to the new edition of Dr. Bonar's well-known book. First published in 1885, it has long ago taken its place as a standard work and will now draw a still larger circle of readers. As the author says, it is not a treatise on population, but an account of one writer on population, and, we may add, a very illuminating and sympathetic account. There is a certain resemblance between Malthus and Darwin both in character and achievement. They were both retiring in disposition, courteous in manner, and capable of inspiring deep affection. They both

attained sudden fame by the publication of a single book; they were greatly maligned and, while feeling the attacks made upon them, were recompensed by the knowledge that they had in general gained the assent of the eminent men of their day to their views. Lastly, they both sought to avoid controversy and devoted themselves to gathering fresh evidence, leaving their supporters and detractors to fight it out among themselves.

Dr. Bonar has somewhat expanded the bibliographical section of his book. Otherwise it remains as it was, with the addition of certain notes. It is a book with which all those who interest themselves in population problems, and among them are nowadays many biologists, will wish to make themselves acquainted. A. M C.-S.

Relativity and Cosmology.

(1) *Einstein's Theory of Relativity.* By Prof Max Born. Translated by Henry L Brose Pp. xi + 293. (London: Methuen and Co, Ltd., 1924.) 12*s.* net

(2) *Space and Time. an Experimental Physicist's Conception of these Ideas and of their Alteration.* By Prof. Carl Benedicks. Pp xiv + 98. (London: Methuen and Co, Ltd., 1924) 4*s.* net.

(3) *The Theory of Relativity.* By Dr. L. Silberstein. Second edition, enlarged. Pp. x + 563 (London: Macmillan and Co, Ltd., 1924) 25*s.* net.

IT is nearly twenty years since Einstein wrote his epoch-making paper on the electrodynamics of moving bodies, in which the fundamental principles of the theory of relativity were first clearly enunciated, and apparently the theory is now approaching the completion of the stage of formal development on one hand and of popular exposition on the other. Writers are beginning to turn their attention to work of a more critical character on the roots of the theory — its logical bases and fundamental concepts — and to the detailed investigation of its outlying branches, spreading far into distant regions — the quantum theory, cosmological theories, and so forth. The three books under review are typical of this process in some respects, and each is well worthy of the reader's attention.

(1) The first book, by Max Born, the successor of W. Voigt in the chair of mathematical physics at the University of Göttingen, and himself well known for researches in the theory of relativity, is considered by some to give the best popular exposition of Einstein's theory in the German language, and for this reason alone an English translation is very welcome. It arose out of a course of popular lectures on the subject delivered in the winter of 1919–1920 to an audience without any knowledge of the technique of either mathematics or physics, and, although naturally the treatment has been modified somewhat with a view to publication, the result is an eminently readable account of the subject. No doubt it will in its English guise prove very useful, not only to the general reader and to the popular lecturer, but also to the university student in his first or second year with only a slender equipment of mathematics and physics. The treatment in the main follows the historical order of development, but always with special reference to questions of absolute and relative motion and similar changes. The first twenty-five pages are devoted to a brief sketch of Newtonian mechanics and Newton's ideas of absolute space and time, the next fifty to the fundamental laws of optics, including optical effects in moving bodies, and about sixty more to the fundamental laws of electrodynamics up to and including the theories of Hertz and of Lorentz, and an account of the Michelson-Morley experiment. On this broad foundation the special theory of relativity is expounded in fifty pages, and the general theory in a further forty pages, both mainly on the lines laid down by Einstein. The translation is good, misprints are conspicuous by their absence, and the print and style of production excellent.

(2) In the second book, Carl Benedicks, the eminent Swedish metallographist, deals with the fundamental principles of space and time measurements from the point of view of the experimenter rather than the logician or mathematician. He prefers the traditional views as to the absolute character of space and time and their independence of one another, and considers the reasons put forward by Einstein and his school for changing them to be quite insufficient. Without in the least minimising the value of Einstein's explanations of such residual effects as the deflexion of light by the sun and the advance of the perihelion of Mercury's orbit, he does not consider them to be decisive tests of the theory. He directs attention to a remark of Poincaré's to the effect that "if one explanation of a phenomenon is found, there are also an infinite number of other ones to be found," and points out that other explanations of both effects have been given already—by Von Soldner a hundred and ten years before Einstein for the deflexion of light, and by G. Bertrand recently for the perihelion effect. He inclines to the opinion that an emission theory of light, on the lines of the ideas put forward by W. Ritz just before his decease, might be constructed in such a way as to meet these difficulties without necessitating complete changes in the traditional concepts of space and time; for example, on this view an electron is regarded as the "centre of an iterated explosion." Whatever one may think of the author's conclusions, one must admit that this

book of some hundred pages contains much that is interesting and suggestive, and raises several questions well worthy of the attention of relativists, such as the realisation of a true plane by the engineer's method of constructing three mutually fitting face-plates, the synchronisation of two distant clocks by the mechanical device of two wheels connected by an axle free from torsion, etc. It can be strongly recommended to any one interested in the logical bases of mechanics and physics.

(3) The third book, by L. Silberstein, is in many respects the most important of the three, at any rate for the relativist, but no doubt it presupposes a much more extensive mathematical and physical equipment than the other two; it is the second edition, and at the same time an extensive development of the book on the theory of relativity published by the same author in 1914, and reviewed in NATURE of December 10 of that year. That book is reprinted practically without change and forms the first ten chapters of the present work, so that nothing further need be said about this portion. The six added chapters with a number of miscellaneous notes at the end, amounting to about two hundred and sixty pages, or a little less than one-half of the whole, deal with the extensions made in the theory since 1914, mainly in connexion with the general theory of relativity and gravitation, with detailed reference to its cosmological applications. The old and new parts of the book together constitute what is perhaps the most complete text-book in the English language on the theory of relativity and gravitation in all its ramifications, certainly the fullest on its cosmological aspects. It is worthy of a place beside the standard treatises of Eddington and of Weyl, but not quite as mathematical as the former and perhaps wider in scope than the latter, and written from rather a different point of view than either, so that the three books are in a sense complementary to one another.

The author has evidently been at great pains to make the physical meaning of each step in his argument and of every mathematical result as clear as possible, even to a reader not possessed of the very considerable mathematical equipment needed for a thorough understanding of the general theory of relativity. To expect complete success in this respect would, however, be unreasonable, seeing that there are plenty of mathematical processes and results in the theory, about the geometrical and physical meaning of which even experts are not yet fully agreed. We ought to bear in mind what were the conditions respecting the geometrical interpretation of the axioms and concepts of Euclidian geometry before the times of Gauss, Bolyai, and Lobatschewsky, or the physical interpretation of the concepts and laws of Newtonian mechanics before the time of Mach, particularly in view of the great age of these branches of knowledge as compared with the twenty years of relativity.

Coming to details we note that the first of the new chapters, the eleventh of the whole book, gives a very readable account, without any formidable array of mathematical symbols, of the logical and historical development which led Einstein from the special to the general theory of relativity. The metrical tensor of the field is introduced, its geometrical and physical implications are considered summarily, and the world geodesics are defined and their physical interpretation is explained. The twelfth chapter is purely mathematical; in fifty pages a brief account of the tensor calculus is given, Levi-Cività's concept of parallelism is explained, and the Riemann-Christoffel tensor is introduced in much the usual way. Naturally, the limitations of space imposed by the plan of the book make this chapter difficult for any one not already acquainted with the subject; full references are given to the original authorities, but it might have made it easier for the beginner if reference had also been made to fuller text-books on this particular branch, like those of Galbrun and of Rothe.

The thirteenth chapter deals in some twenty pages with the physical interpretation of geodesics in detail, and is noteworthy in two respects. In the first place, it is shown that in the rest system of a freely moving particle the equations of motion of Einstein become identical with the Newtonian equations, not merely approximately, as is generally known, but rigorously. Secondly, the treatment of the light paths, or rays, is novel and is utilised to obtain the theory of the experiments reported to have been carried out by Michelson at the Yerkes Observatory with the object of testing Einstein's theory by an absolutely direct method. The fourteenth chapter, of fifty pages, treats of the gravitational field equations and the material energy tensor in much the same manner as in other books, attention being confined, however, to the centrosymmetrical solutions and to Einstein's approximate method. Within these self-imposed limits the author gives an exceptionally complete treatment, including, as he does, an account of de Sitter's geodesic precession and also of Grossmann's critique of the perihelion effect.

The fifteenth chapter deals with electromagnetism and gravitation by a little-known method due to Kottler and based upon Minkowski's exposition of the special theory. In about twenty-three pages the author works out the field of a gravitating electric particle, as it were from first principles, a method of treatment which possesses certain advantages from the student's point of view over the usual method based on the principle of least action. The last seven pages of this

chapter contain a very brief sketch of variational methods, of which the author does not appear to be particularly enamoured; but he gives full references to the original authorities with the exception of de Donder, whose "Gravifique Einsteinienne" is not so well known as it deserves. The five new chapters so far considered cover the ground usual in text-books on the general theory of relativity, but in some respects the treatment is novel and more complete than usual, as we have pointed out here and there. The chief peculiarity of the book, however, lies in the very complete account of the cosmological aspects of the general theory of relativity, which fills nearly one-third of the additional space, about eighty pages.

The author devotes the first thirty pages of the sixteenth and last chapter to a very detailed critical discussion of Einstein's cosmology, based on the assumption of a finite elliptic space filled with matter, uniformly distributed on the average. He explains very clearly how this cosmology leads unavoidably to the existence of singularities of the metrical field—antisuns—at places where there need be no concentration of matter at all, and is therefore untenable, a conclusion in which he agrees with other writers. The remaining thirty or more pages of this chapter are devoted to a detailed study of de Sitter's cosmology, to which the author is evidently favourably disposed. He discusses de Sitter's spectroscopic distance effect, as well as the more general combined Doppler effect, due both to distance and to radial motion of a celestial object—star, nebula, or cluster—in considerable detail, in the light of Slipher's table of radial velocities of spiral nebulæ and Shapley's tables of the radial velocities of globular clusters. Finally, there are fifteen pages of miscellaneous notes dealing mainly with questions relating to world-curvature and cosmology, but also with some recent experimental results regarding the solar spectrum shift, the deflexion of light by the sun, and spectrum shifts of distant celestial objects. Although most relativists would perhaps be loth to lay so much stress as the author does on observations relating to very distant celestial objects, on account of the very speculative character of some of the interpretations put upon them, yet it must be conceded that there is much to be said in favour of the author's view that these observations do lend substantial support, so far as they go, to de Sitter's cosmology, which treats space as finite, elliptic, and generally void of matter, except for the presence here and there of isolated singularities, such as the sun and the stars.

This brief survey sufficiently shows that we have before us a book of great interest, which deals with many of the problems arising in the general theory of relativity in a detailed, novel, and up-to-date manner. It may be objected that it is premature to devote so great a proportion of the whole book as one-sixth to so speculative a branch as cosmology, but there is good reason to be thankful to the author for giving us so full an account of this usually neglected portion of the theory. For this and many other reasons, Dr. Silberstein's book is one which no one interested in the theory of relativity can afford to ignore.

The Canadian Arctic.

(1) *With Stefansson in the Arctic.* By Harold Noice. Pp. 270 + 16 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 7*s* 6*d*. net.

(2) *The Arctic Forests.* By Michael H. Mason. Pp. xiii + 320 + 53 Plates. (London: Hodder and Stoughton, Ltd., 1924.) 20*s* net.

(1) THE facile pen of Mr. Vilhjalmur Stefansson has already made us familiar with the Canadian Arctic islands and his views on the friendliness of Nature in the polar regions, but we may say without prejudice to the leader of the expedition that one needed the opinions and feelings of a rank-and-file member of the party to drive home the theories of the enthusiast. Mr. Noice tells in a frank and pleasant way the events of many months of intimate companionship with his leader, and incidentally unfolds his gradual conversion to the beliefs of Stefansson in a way which carries more conviction than the calm and scientific statements of "The Friendly Arctic" could do. There are also many gaps in the earlier narrative which are filled up in this, and new sidelights are thrown on some aspects, as, for example, on the insubordination which so frequently marred the plans and diverted the purpose of the expedition.

To British readers, accustomed now to Antarctic ventures, which of recent years have held the field, the expedition presents many unique features. The various headquarters of the expedition were rarely more than 300 miles from the Canadian mainland and not much more from the settlement at Herschel Island. In consequence, there were frequent opportunities for refitting from visiting whalers, or of dashing across to find new men or ships, a convenience which proved of doubtful value. Although it enabled the leader to buy or charter no fewer than four ships at various times, it also meant taking with them several men whom he could have done better without. The method of employing Eskimo men and women, though not new, was very thoroughly carried out, several women being at an advanced headquarters within 300 miles of the farthest point reached.

The most unprecedented feature of the expedition was the reliance for food on what could be found on the

land and under the ice, and the proof positive that for many parts of the region visited there is no need for any one to die of starvation so long as he is able to hunt. The abundance of animal and vegetable life is little short of amazing, and the demonstration carried out over some five years, that white men can live and hunt in the Eskimo method, is perhaps the greatest service the expedition has rendered to polar exploration.

The claim made in some quarters that this has ended the days of expeditions going out fully equipped from civilisation cannot be said to be substantiated, or at all events must not be accepted without challenge. To one who has served on what Mr. Stefansson humorously calls a "groceries" expedition, where little thought and the minimum of time was given to the daily food problem, the chief and lasting impression of these two narratives is the amount of time which has to be given up to hunting and cooking, and, one may also add, the number of caribou or ovibos (musk ox) required to support a party of three or four men with dogs. That a man of the mental calibre of Mr. Stefansson should have to spend day after day hunting for the party may have proved the efficiency of the white man, but at the same time it must have robbed us of a vast amount of skilful scientific observations.

It is true that the loss of time spent in hunting was to some extent made up by the rapid methods of travel which the parties used, and their ability to travel in almost any weather. The mileage travelled by Noice himself and by others is astonishing, though, owing to unforeseen circumstances, a great deal of it was spent in mere message-taking from one party to another. While the loss of two experienced men on one of the journeys warns us that the friendliness of the Arctic is strictly a relative term, there is no doubt that Mr. Noice's book supports the earlier one in demonstrating that life in the Canadian Arctic islands can be pleasant and exploration a mere matter of time, provided that Eskimo, and white men trained to Eskimo methods, are taken.

(2) In Mr. Mason's book we have the same kind of tale, though in slightly more favoured latitudes. The rapid development of the Alaskan territories and the amenities of life there now are little known to us in the Old World, who are apt to look to the tales of hardship in the early days of the "Yukon" for our ideas on the subject. The book perhaps attempts too much, in that it ranges from anthropological classifications through true and thrilling stories of camp life to imaginative tales of death and disaster. Each section is well written, but cannot claim its full effect when side by side with the others, and indeed conveys the impression of a guide-book compilation, which it is not. But the author most certainly succeeds in his purpose of giving an "accurate general idea" of the country, and will doubtless convert many readers to his firm belief in its future. We too are ready to dream of first-class dining-cars running to the shores of the Arctic Ocean during the summer, since the mineral wealth of the country is able to pay for them, but we hesitate to follow so readily the author's claim that it is only a matter of time before cereals will be acclimatised so as to feed the growing population without dependence on outside sources.

F. DEBENHAM.

Applied Chemistry.

The Constituents of Coal Tar. By Dr. P. E. Spielmann. (Monographs on Industrial Chemistry.) Pp. xii + 219. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

Aniline and its Derivatives. By P. H. Groggins. Pp. vii + 256. (London: Chapman and Hall, Ltd., 1924.) 18*s.* net.

THESE two books present a sharp contrast which is of particular interest at the present time, when many people are concerned to notice in some of our educational institutions a tendency towards early specialisation and the consequent granting of degrees and diplomas to students who have not received, and have not had time to receive, a thorough training in the sciences underlying the branch of applied chemistry they have chosen to adopt. For, after all, applied chemistry is applied *chemistry*, that is to say, it is a branch of chemistry, not a science of itself, and a chemist is, or should be, a *chemist* before he elects to follow any of the numerous branches of the parent science which will enable him to adopt an adjectived or hyphenated title. It is scarcely possible to insist too strongly on this point because it is difficult adequately to acquire the fundamental principles of a science in later life, and the early neglect of a suitable foundation leads to personal limitations which are difficult to overcome and are apt to hamper the usefulness of the individual not only to himself but also to the community at large.

One of these books is by an English author; the other is by an American. The shock is, therefore, not so great when one reads in the preface to the American book that chemistry is a branch of the engineering profession.

We in Great Britain are still in the throes of producing a chemical engineer or an engineering chemist fully armed and equipped from out of our universities, and we are not yet all agreed as to how it can best be done in the time available, or as to whether the engineer is to be superimposed on the chemist or the chemist on the engineer. Indeed, many of us think that

the term should only be applied to those chemists who have had at least five years' works practice. In the United States there appears to be no such problem, and many of the universities in that country have granted degrees in chemical engineering for some time past.

(1) In his introduction to the series of monographs on industrial chemistry, Sir Edward Thorpe stated definitely that "they will serve to show how fundamental and essential is the relation of principle to practice," and, now that seventeen volumes of the series have appeared, it is possible to realise how closely this wise provision has been followed. It is sometimes urged by reviewers and others that the volumes do not deal with industrial chemistry at all, but are merely compilations of academic interest. This is not the case, and the present volume by Dr. Spielmann is an instance in point. It was not intended that these volumes should "cover the whole ground of the technology of the matters to which they relate" or be "concerned with the technical minutiæ of manufacture except in so far as these may be necessary to elucidate some point of principle." They are intended for the use of chemists in the real sense of the word, whether academic or industrial, who wish to acquaint themselves with the general practice and most recent development of the branch of applied chemistry under treatment. In these ways Dr. Spielmann's book is a notable addition to the series and will be welcomed by all who desire to follow the most recent advances in coal tar chemistry.

The book is well printed and the formulæ are clear, but to any reader who is not an expert organic chemist they may cause trouble, because there appears to be no uniformity of treatment. For example, sometimes the formulæ are written in full as in chrysene (p. 103), sometimes in abbreviated form as in naphthacene (p. 104) Often the aromatic nuclei are represented as simple rings without adornment (naphthalene, p. 72), often the Kekulé double valencies are included (quinaldine, p. 159). Sometimes hydrogen atoms are placed at the angles of the benzene hexagon either without the double valencies (coumarone, p 135) or with them (indene, p. 73). The effect even on the expert reader is apt to be irritating, and the author might well consider an alteration in this connexion for future editions Had this book been discovered in Tutankhamen's tomb and constituted the sole evidence of the type of graphic formulæ used by the ancient Egyptians, no Rosetta stone would have enabled modern men of science to solve the problem.

(2) It is stated in the preface of Mr. Groggins' work that this book is intended "for the student of chemical engineering as well as the graduate engineer or works chemist." It is not clear if the "or" in the above sentence implies that the last two terms are synonymous, but, in any case, it is certain that the author intends his book to appeal to a wide circle. It constitutes a sharp contrast to Dr. Spielmann's book, which is written essentially for the educated chemist and would, in all probability, prove irksome to the usual engineer manager In other words, it is an outcome of the view that the engineer without fundamental chemical training can be supplied with a sufficient working knowledge of the chemistry and physics of a process to enable him to carry through without the aid of a competent chemist. The book is, therefore, replete with drawings of plant and the technical minutiæ of aniline manufacture.

It is not the writer's object to quarrel with the method employed, but only to wonder if a book of this kind is really of educational value or whether it is not rather a book of reference. So far as the treatment is concerned it is admirable, and it represents the last word in the technology of aniline manufacture. The chemical theory is a bit scrappy, and if a firm were to rely on the technical information supplied in order to start the manufacture of the base it would, in all probability, have spent all its spare capital long before it had decided on which process to adopt. Nevertheless, as a record of the chief processes involved, the book is of real value, and of special importance and utility are the chapters on cost factors (p 91), and on thermal factors (p. 104), for these are matters, essential to engineers and chemists alike, to which too little attention is given; the article on the chemist's budget (p. 97) is particularly noteworthy and will well repay attention. The chapter on aniline poisoning (p. 117) provides some startling facts, and that on general chemical and physical data (p. 131) gives information not readily available elsewhere. The book is readable and well set up. It should be read by all who have an interest in the subject with which it deals.

J. F. T.

The Teaching of Physiology and Pathology.

(1) *A Text-book of Physiology.* By Prof. H. E. Roaf. Pp. viii+605. (London: E. Arnold and Co., 1924.) 25*s* net.

(2) *Text-Book of Pathology.* By Prof. Robert Muir. Pp. vii+774 (London: E. Arnold and Co., 1924.) 35*s*. net.

(1) PROF. ROAF'S volume is based on the course of instruction given at the London Hospital Medical School, and represents, presumably, a scheme for the presentation of the facts of physiology which he has found to be more satisfactory in its results than the traditional method, for it marks to some extent a new departure in text-books on the subject.

Hitherto it has been usual to consider as a group or system those organs of the body which act together for a common end. Thus the physiology of the alimentary system has embraced a description of all those organs the main function of which is to bring about digestion and absorption of an animal's food. They have been compared and contrasted as regards their structure, function, and the means whereby their function is regulated in order to further the ends for which they are designed and to assist in the co-ordination of the body as a whole. In the work under review this method is not adopted, but, instead, the subject of animal physiology is approached from the point of view of the chief activities which an animal displays Mechanical aspects are dealt with in the first section, chemical activities in the second, regulative mechanics come next and occupy the largest section of the book, and, finally, a special section is devoted to the maintenance of the individual and reproduction.

However logical this method may appear in theory, it is not always satisfactory in practice. If there is one subject more than another in physiology in which the thermal, chemical, electrical, and mechanical phenomena associated with its action have contributed as a whole to the understanding of its mechanism, it is that of muscle. It would seem best, therefore, in dealing with the physiology of muscle, to consider these phenomena in succession in order to show what light each has thrown on the working of a muscle. This, however, has not been done. The thermal, mechanical, and electrical changes are described in one section and chemical changes in another, where they are grouped with processes of absorption, excretion, and secretion, with which they have little in common except that in each there is a degradation of energy. Other examples illustrating the difficulties of this scheme of treatment might be given On the other hand, there is much to be said for a book modelled on these lines, in that it gives the student a new point of view and directs his attention to fundamental likenesses in many aspects of bodily activity which might well escape him in reading text-books written on more familiar lines. Were the book a text-book of general physiology, then it could certainly be conceded that the method of treatment adopted by the author is the right one.

Here and there some lack of perspective is shown regarding the space devoted to certain subjects. For example, the reaction of sugars with phenyl hydrazine is spread over a page and a half, whereas the depressor nerve and its functions receive only half a page. The book is well illustrated and contains some new and useful diagrams.

(2) Prof. Muir's book is founded on the course in pathology given at the University of Glasgow. The earlier chapters deal with general disturbances of nutrition and of the circulation, the phenomena of inflammation and its sequelæ, and infection, immunity, and fever. Then follows a section devoted to the description of tumours and their causation, and finally, the lesions which are met with in the various systems of the body—circulatory, respiratory, alimentary, etc. —are discussed. Although there is thus a division of the subject into general and special pathology, it is not apparent in reading the book that any real separation under these two heads occurs. That is one of its virtues. It is sometimes said that pathology is the study of physiological processes which have "gone wrong," and there is a good deal of truth in this somewhat bald statement What it implies is that many phenomena met with in pathology are really the result of physiological reactions proceeding, it may be, to excess or in an abnormal direction Prof. Muir rightly emphasises this in his introduction, and, what is more, makes practical application of it in his method of teaching. Wherever one turns in the book, this underlying idea can be discerned. We feel, therefore, that the student who has just completed his course in physiology and has then begun his study of pathology, guided by this book, will find a natural sequence in description, explanation, and discussion which is too seldom met with in books devoted to subjects of the medical curriculum The book thus makes a useful bridge to the gap, which in the past has been too apparent, between the subjects of the second M.B. examination and those of the later period of the medical student's course.

Accounts are given in appropriate places of the investigation of pathological processes by other means than the microscope. This instrument has rendered inestimable services in the past and it will no doubt do so in the future, but other methods are available as adjuncts to it, and the experimental investigation of pathological processes is likely to be fruitful in helping to elucidate the initial causes of disease and to explain disturbances of function which result from them. The discussion of the results of such methods is not common in text-books of pathology and is therefore to be commended.

The book is admirably proportioned and the illustrations are one of its special features. The author is to be congratulated on them. They are all reproductions of photographs which have been made with great technical skill, and it is obvious that they have been carefully selected. We feel sure that the book will be widely welcomed by both students of medicine and those engaged in teaching and clinical practice.

H. S. R.

Our Bookshelf.

PSYCHOLOGY.

Crime and Insanity. By Dr. W. C. Sullivan. Pp. vii+259. (London: E. Arnold and Co., 1924.) 12*s.* 6*d.* net.

As Medical Superintendent of Broadmoor Asylum, Dr Sullivan is in a position to speak with authority on a subject which is now arousing considerable interest, not only in medical men and jurists, but also among the general public. There is no lack of literature dealing with disorders of conduct from the point of view of the alienist, and with criminal responsibility of the insane considered on the standards imposed by the law. The efforts of the author of "Crime and Insanity" have been directed towards presenting the abnormalities of conduct which are dependent on mental disease, as clinical features demanding a study of their nature and origin, and this book is a proof that when approached on these lines, the more special question of criminal responsibility becomes less complex and loses much of the obscurity with which legal subtleties have cloaked it.

Responsibility is rightly recognised as being a purely legal question, the law expresses the attitude of the ordinary man of common sense, living at this time and in a particular country. The McNaughten rules, which are always applied as the law of England, though they bear the dignity neither of parliamentary enactment nor judicial decision, enunciate the opinion of the bench of judges in the year 1843. It must be agreed that they do not represent the general feeling of public opinion to-day, and it is widely recognised by lawyers and medical men that they are inadequate; their interpretation by judges is variable and they are rarely applied rigidly. Dr. Sullivan points out that the test is unsatisfactory because it is based on a misconception of the facts; he advocates the adoption of a simpler test of responsibility, the admission of qualified responsibility, and the establishment of a system for providing the court with expert evidence concerning the mental state of the accused.

Most of this book is devoted to clinical material, and there are numerous descriptions of cases illustrating the criminology of the various types of mental disorder. It is an important and practical contribution to the literature of insanity.

VIIth International Congress of Psychology, held at Oxford from July 26 to August 2, 1923, under the Presidency of Charles S. Myers. Proceedings and Papers, edited by the President. Pp. xxv+388. (Cambridge: At the University Press, 1924.) 12*s.* 6*d.* net.

THE various papers collected in this report have a high intrinsic value, but the greatest interest of such a collection is to be obtained by comparing the different points of view rather than by studying the individual contributions. The discerning reader can thus obtain a trustworthy insight into the recent progress of psychology, a knowledge of its present position, and even perhaps a prognostication of its future development. The collection is representative of modern psychological thought, containing, as it does, papers from most of the leading British psychologists and from many eminent foreigners. The editorial succeeds in emphasising the cordial international relationships which were so evident to all who attended the congress, but it seems unfortunate that no allowance was made for British linguistic ignorance by adding an English summary of the foreign papers.

Particularly interesting to the general reader are the various symposiums—"The Nature of General Intelligence and Ability," "The Conception of Nervous and Mental Energy," and "The Principles of Vocational Guidance"—but where there are so many valuable papers it seems invidious to particularise. All who wish to be abreast of the times in psychological thought will find this volume a necessary addition to their shelves.

Special Talents and Defects: their Significance for Education. By Prof. Leta S. Hollingworth. (Experimental Education Series.) Pp. xix+216. (New York: The Macmillan Co., 1924.) 7*s.* 6*d.* net.

OUR eyes turn naturally towards the unusual; the one exception to the rule is often more interesting to study than the ninety-nine corroborating cases. There is certainly scientific value in such a study, for a fruitful suggestion is often obtained by comparing the normal with the abnormal to find their common factor.

Prof Hollingworth writes of the exceptional child who shows a particular gift or deficiency in some scholastic subject not to be expected from his general mental level. The subject is introduced by a helpful discussion on the nature and causes of abilities and of their inter-relations, and then proceeds to a consideration of the neural base involved. The main part of the book is devoted to a detailed presentation of extreme variations of ability in the ordinary school subjects. A chapter each is given to reading, spelling, arithmetic, drawing, and music; cases are cited, and causes and remedies are discussed.

Every teacher of experience has met children who astonished him by some such unexpected gift or defect. This book is valuable for its clear explanations and practical advice in connexion with such phenomena.

NATURAL HISTORY.

(1) *Everyday Doings of Insects.* By Evelyn Cheesman. Pp. 245. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 7*s.* 6*d.*

(2) *The Great Little Insect.* By Evelyn Cheesman. Pp. 256. (London: Hodder and Stoughton, Ltd., 1924.) 6*s.* net.

THESE two books, as may be gathered from their titles, are written essentially for the instruction and entertainment of lay readers. Their author, who is curator of insects at the Zoological Gardens at Regent's Park, London, is well qualified to enlighten the public as to many of the facts and theories respective to insect life. In her official position she is enabled to judge to a large extent what type of book will meet the demands which she is catering for. Both volumes are written in a clear, attractive style and with a "freshness" that comes as the result of a first-hand acquaintance with the objects concerned.

(1) The little book entitled "Everyday Doings of Insects" is written with the intention of supplying answers to some of the questions that are often asked concerning the exhibits in the Insect House at the Zoological Gardens. It is more especially addressed to boy inquirers with the view of encouraging their interest in entomology. The photographs and sketches have been made from the living insect in almost every case, and they add greatly to the attractiveness of the volume.

(2) "The Great Little Insect" is intended for older readers, and consists of a series of essays discussing various activities of insects and the laws which we believe govern them. In these chapters the author has brought together many facts which, although well known to the entomologist, seldom reach the lay public Such facts are weaved together in an interesting manner, and the volume is a fascinating one for the fireside reading of winter evenings.

Illustrations of the British Flora: a Series of Wood Engravings, with Dissections, of British Plants. Drawn by W. H. Fitch, with additions by W. G. Smith and others. Fifth revised edition. Pp. xxvii + 338. (London: L. Reeve and Co., Ltd., 1924.) 12*s.* net.

THE appearance of the fifth revised edition of the "Illustrations of the British Flora" completes the republication of "Bentham's Handbook of the British Flora." It is universally acknowledged that both the text (now called the Handbook) and the illustrations have been of great use to several generations of botanical students, especially beginners. It is, however, unfortunate that the two volumes have been reissued without more drastic alterations having been made. A considerable number of serious mistakes are perpetuated, as, for example, in Fig. 933, where the leaves of *Populus canescens* are figured as *P. alba*, and in Fig. 935, where the catkins of one species and the leaves of another are figured under the name of *P. nigra*.

The common vernacular names and, for many species, a letter to indicate the flower colour have been added to the botanical names for each figure. A new index has been compiled, giving, in single sequence, the generic and common names. A summary of family characters and an analytical key to the families and anomalous genera are reproduced from the Handbook. Several new figures are incorporated, but they are not up to the standard set by Fitch.

The Teaching of Biology in Schools and Training Colleges. By Ethel M. Poulton. Pp. xv + 112. (Birmingham: Cornish Bros., Ltd., 1924.) 5*s.* net.

BIOLOGY, as here considered, is not that of the specialist in zoology or botany, but rather that for which a place is claimed in the general education of all pupils, and especially of those in primary and secondary schools. In addition to minor, but not unimportant, objects, the chief aim of such general biology is rightly stated to be the stimulation of interest and curiosity, and to produce enjoyment, both æsthetic and intellectual, of Nature. The opening chapters of this useful little book contain an eloquent *apologia* of biology, based upon a consideration of its values and aims, and of the psychological factors which should influence the selection of material and the methods of teaching. The teacher who would be ready to give an answer for his faith in biological teaching will find here his brief set out in excellent style. In subsequent chapters the author has constantly in mind the students at training colleges. Though, perhaps, she says nothing that is entirely new on courses of Nature study and the more advanced work, she has nevertheless done good service to all teachers of biology in bringing together, and more or less codifying, the general principles by which all should be guided, and not less in pointing out the many pitfalls that beset the path of the inexperienced. Stress is very properly laid on the importance of presenting biology as a study of *living* things.

BACTERIOLOGY.

Practical Bacteriology: an Introductory Course for Students of Agriculture. By Andrew Cunningham. Pp. vii + 188. (Edinburgh and London: Oliver and Boyd, 1924.) 7*s.* 6*d.* net.

A LARGE amount of information is contained in this small book, which is well planned and very readable. Bacteriological technique is described in the earlier sections: preparation and sterilisation of culture media, the use of the microscope, and staining methods and cultivation. A series of exercises then follows, each dealing with some particular subject or process, and so arranged that the student becomes familiar by easy stages with bacteriological methods

The bacteriology of milk and dairy products, of soil and manure, is then similarly dealt with, some of the special reactions applied to milk being also included, namely, the catalase, curd, and other tests.

In the final chapters some of the more important bacterial plant and animal diseases are described, and classification and formulæ are given in appendices. The practical exercises for the most part are simple and easily carried out in a short time, and have been chosen with commendable discretion; any one who worked through the lessons with some supervision should possess a considerable grip of bacteriology. The book is well produced and illustrated

Elements of Water Bacteriology: with Special Reference to Sanitary Water Analysis. By Prof. S. C Prescott and Prof. C E. A. Winslow. Fourth edition, rewritten Pp. ix + 211. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 11*s.* 6*d.* net.

THE work under notice is, on the whole, an excellent monograph on water bacteriology. First published twenty years ago, the present edition has been revised throughout. The procedures outlined are those of the Committee on Standard Methods of the American Public Health Association, and in some respects differ from those current in Great Britain. Chapters on the bacteriology of sewage and sewage effluents and the bacteriological examination of shell-fish are included. Much information has been collected on *Bacillus coli* and its variants and methods for their detection and isolation, though some of the fermentation reactions of the allied organisms are incorrectly given. One of the most important chapters is that on the significance and interpretation of bacteriological examinations of water, and the position taken is a thoroughly sound one. A bibliography running into twenty-nine pages completes this useful book.

Louis Pasteur. By Prof. S J Holmes. Pp. vi+246+4 plates. (New York: Harcourt, Brace and Co, 1924.) n.p

THIS short biography gives all the essential facts of Pasteur's life and work. Commencing with his early days, the salient features of his researches and discoveries are summarised in chronological order, and for the uninitiated reader explanatory paragraphs are introduced where necessary. The text is very readable, and is illustrated with several figures and some good portraits. A sympathetic account is given of the celebrations on Pasteur's seventieth birthday and of his last days, and we leave the great veteran sleeping in the beautiful little chapel in the basement of the Pasteur Institute, where "four angels watch over him, Faith, Hope, Charity, and Science, and in the laboratories above his tomb, his great work is going on."

METALLURGY.

Practical Microscopical Metallography. By Dr R. H Greaves and H. Wrighton Pp. x+125+28 plates. (London. Chapman and Hall, Ltd., 1924.) 16*s.* net.

THE authors state in their preface that their intention is "to provide, within a small compass, a set of typical photomicrographs suitably annotated and accompanied by an account of such related matters as might profitably occupy the minds of students during the necessarily long hours—many of them spent in purely mechanical operations—devoted to microscopical work," and that the book is intended both for metallurgical students and for students of engineering who study metallography.

We feel some doubt as to whether the book will be found useful. So far as metallurgical students are concerned, it is so restricted in scope that it could not serve as an adequate introduction even to microscopical metallography None of the chapters deal with the construction of the equilibrium diagram and thermal methods of investigation which, in conjunction with microscopical work, constitute the experimental data on which the diagrams are based. With respect to engineering students, it is necessary to face the fact that the properties of any metal or alloy cannot be deduced from its microstructure. The polyhedral structure, characteristic of a pure metal, holds equally for tough and ductile metals on one hand, and for brittle metals on the other Even the most skilled metallographer confronted with a photograph representing the microstructure of a metal or alloy, of the chemical composition of which he was unaware, could say very little about the mechanical properties it would be likely to possess. We doubt whether any student of engineering, in the absence of previous knowledge of the subject, could grasp the real implications of the equilibrium diagrams reproduced in the book, and whether he could form a true mental picture of the facts which they convey It seems to us that the book cannot do much more than awaken an interest on the part of metallurgical and engineering students in the subject of microscopical metallography, and a desire to study the subject in a much broader way such as is afforded by one of the numerous text-books of metallography already available.

The Planning, Erection, and Operation of Modern Open-Hearth Steel Works. By H. Hermanns. Pp. vii+307 (London: Ernest Benn, Ltd., 1924.) 42*s.* net.

MR. WESLEY AUSTIN has performed a valuable service to English metallurgy in translating Mr. Hermann's important work on the planning and operation of modern open-hearth steel works. Technical literature is rich in works which concern themselves with descriptions of the metallurgy of steel production in open hearths. The auxiliaries, however, which serve to carry out the metallurgical work and to lighten or cheapen the mechanical operations, have been given only secondary attention. They are of equal economic importance to the processes, and in great measure not only render these possible, but also assure their efficiency. The point driven home in this book is the economy which results from excellences in furnace design and equipment, from attention to practical expediencies in the general arrangement of plant, and from a careful lay-out of storage, handling, and transport facilities Every type of equipment for open-hearth steel production is described in detail and very clearly illustrated, not only from Continental practice but also from a very close study of English and American practice. The book is intended on one hand for the steel works staff and managers and, on the other hand, for technical and higher grade students. In addition, it should provide hints for designers and draftsmen. It is abundantly illustrated by clear drawings, which are one of the best features of the book. We think that Mr. Hermann's work would repay careful study by the management of every open-hearth steel works in Great Britain.

Arc Welding Handbook By C. J. Holslag. Pp. xi+250. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 10*s.* net.

THIS book is intended to serve as a simple and practical manual of instruction in arc welding. An attempt has been made—and made successfully—to describe the methods step by step in a clear and practical manner so that the beginner may understand both the equipment and the processes. The author has also kept in mind those men who may supervise the work, so that there may be no mystery to them about what the welding operator is trying to accomplish. The book is very clearly written and illustrated by numerous figures

The early chapters deal with the various types of welds that can be produced. Regard is paid both to thin and heavy sections. We have found the chapter on the welding of cast iron and malleable iron particularly interesting. There is an illustration on p. 125 of a 15-ton cast iron gear housing which had been broken in eight pieces and was afterwards mended by arc welding. A total length of 190 feet of welding 1½ inches thick was required. Considering the brittleness and low tensile strength of such iron, this must be regarded as a remarkable achievement. Later chapters deal with the welding of structural steel, sheet iron and non-ferrous metals, electric arc cutting, and the welding of alloy steels. The book is full of useful information and may be heartily recommended to those for whom it is intended.

First (Experimental) Report to the Atmospheric Corrosion Research Committee (of the British Non-Ferrous Metals Research Association). By W. H. J. Vernon. Presented to the Faraday Society, December 17, 1923; with Full Report of Discussion. Pp. 839-934. (London: The Faraday Society, 1924.) 7s. 6d. net.

THE research by Mr. W. H. J. Vernon on the tarnishing and fogging of metals, presented to the Faraday Society on December 17, 1923, of which some account has already appeared in our columns (NATURE, February 2, 1924, p. 178), has now been published with a full report of the discussion which took place on that occasion, together with certain communications since received. The discussion is of a thoroughly broad and representative character, and many points of view and interesting items of information were contributed. Mr Lancaster mentioned that although it was generally considered that the purest zinc was the most difficult to dissolve in acids, Mr. Rigg, late of the New Jersey Zinc Company, had found that the purest zinc they had produced for the United States Bureau of Standards was almost explosive under acid treatment; in other words, the rate of solution was very rapid. Taken as a whole, the discussion and contributions add decidedly to the value of the report, and general unanimity was expressed that the most hopeful way of solving the practical problem of preventing the tarnishing and fogging of metals was to attack it by laboratory experiments carried out on fundamental lines of scientific inquiry

ELECTRICAL ENGINEERING.

Small Electric Generating Sets Employing Internal Combustion Engines. By W. Wilson. Pp. 161+16 plates. (London: Ernest Benn, Ltd., 1924.) 18s. net.

MANY are interested in the small electric generating sets that are used for country-house lighting and for supplying electric power for kinematographs, radiographic outfits, etc., in isolated localities. The invention of the tungsten lamp and recent developments in internal combustion engines have made small installations highly desirable in many cases. Most of the books which deal with this subject are now becoming antiquated, so we welcome Mr. Wilson's volume, which describes the best modern practice.

The author has hit the happy mean between a book overburdened with elementary theoretical matter and one that goes into highly technical details, which are only of interest to the manufacturer. So far as lighting current is concerned, electricity can be generated by the consumer at a cost little more expensive than that charged by a public company. But if it is used for heating and power purposes, it compares very unfavourably with a city supply. For many purposes in connexion with farming, electricity can be economically employed. For illuminating yards, stables, and outbuildings it is most valuable, but it is essential to use suitable water-tight fittings. It has now been conclusively proved that the low productiveness of the hen during the winter months is not due to the want of heat, but to the want of light. The lack of daylight in winter can easily be made up by installing a fifty-watt lamp in the fowl-run. It is required from 5 A.M. until dawn and from dusk until 9 P.M. The switching can easily be done by an automatic device. Under these conditions the hens continue to lay almost as in summer, having the requisite time to take more nourishment.

Alternating Current Rectification: a Mathematical and Practical Treatment from the Engineering View-point. By L. B. W. Jolley. Pp. xviii+352. (London: Chapman and Hall, Ltd., 1924.) 25s. net.

THE conversion of alternating current into current pulsating in one direction is a problem which electrical engineers have been studying for many years. In the early days of the industry, a serious drawback to the use of alternating currents for supply distribution was that there was no accumulator suitable for storing the electrical energy, and hence the alternators had to run night and day. Electrolytic valves were then invented to rectify the alternating current, so that it could be used for charging cells. In polyphase systems of supply, this was accomplished mechanically by machines called rotary converters. At the present moment mercury vapour rectifiers are employed in many towns to get direct current from an alternating supply. In connexion with radio engineering all kinds of rectifiers are used. It will be seen, therefore, that the field is a wide one and it is continually expanding.

Mr. Jolley's book opens with a good discussion of wave form, and Fourier's analysis is applied to several problems in an instructive way. The mechanical rectifiers are next discussed, including a brief description of the Highfield transverter. Then we have descriptions of mercury-vapour rectifiers and vacuum tubes. Interesting descriptions are also given of point to plate discharge, vibrating flame rectifiers, corona rectifiers, and photo-electric cell rectifiers. Finally the author discusses the conduction of electricity through liquids, a knowledge of which is necessary in order to understand electrolytic rectifiers and radio rectifiers. Numerous helpful references are given to papers and books. The book can be recommended to research engineers.

Railway Electrification: a Complete Survey of the Economics of the Different Systems of Railway Electrification from the Engineering and Financial Points of View. By Prof. H. F. Trewman. (The Specialists' Series.) Pp. xii+244. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 25s. net.

THIS book gives a survey of the economics of the different systems of railway electrification from the engineering point of view. It is pointed out that for the last thirty years electricity has been successfully employed all over the world to operate tramways. At the beginning of the century it was adopted for elevated and tube railways. Then came the electrification of the suburban railways, and finally, mainly on the Continent and in the United States, the electrification of the main line railways. It is universally admitted that electrification of the main line railways in Great Britain is feasible; the only question about which opinions still differ is the financial one. Were it not for the War, at least two British main lines would have been rapidly extending their systems of electrification. Apparently they have adopted a policy of waiting, and so we are continuing to burn an unnecessary quantity

of coal Many who have considered the problem with great care are in favour of electrification. This book is written for engineers and contains much valuable data from the point of view of the economics of the problem, but we think that the author could have made out a stronger case for electrification. There are not many cases—we know of none—where a railway once electrified has gone back to steam locomotives, but we do know that the electrical staff on most of the English railways is in ludicrous disproportion to the mechanical engineering staff. In Chapter ii. the author states that it can be proved mathematically that the best site for a power house from the point of view of transmission costs is the centre of gravity of the load. This theorem has been recently proved to be erroneous. It requires the unwarrantable assumption that the percentage loss of power in the minimum case is the same for all the distributing mains

MISCELLANEOUS.

Animal Nutrition By Prof T. B Wood Pp viii + 226 (London: University Tutorial Press, Ltd., 1924) 4*s.* 6*d*

THE issue of a text-book on animal nutrition from the Cambridge Research Institute marks a new era in the application of science to the feeding of live-stock in Great Britain For so many years have we been in thrall to German and American literature that to be in possession at last of an authoritative work of native origin, however modest its scope and pretensions, induces feelings so pleasurable as largely to disarm criticism. We hope that the present modest volume may be regarded as but the forerunner of the more ambitious and comprehensive works that should follow in due course from the Cambridge workers

It is a companion volume to Prof Wood's "Chemistry of Crop Production," these works being admittedly of elementary character, and although designed to meet the needs of the elementary student, bear obvious signs that the possibility of a circulation amongst advanced farmers has not been entirely outside the mind of the writer This dual aim would seem to have a strong fascination for the agricultural writer —or does the pressure come more from the side of the publisher?—and the result is rarely entirely satisfactory to either class of reader. Few writers possess the genius of Prof Wood for this class of work, but we venture to think that even he has only attained his end through some sacrifice of the interests of each class of reader Had he been writing solely for the student, who is assumed to have some knowledge of chemistry, he would doubtless have given a rather more advanced treatment of the subject matter of his introductory chapters, whilst a great deal of the detailed experimental work that is embodied in the text might also have been more usefully collected into an appendix or a separate practical manual. For the farmer reader, on the other hand, much of this experimental work must necessarily be unintelligible and consequently redundant These criticisms, however, in no way preclude a very favourable opinion upon the treatment of the subject. In his later chapters, in which he turns to practical applications, Prof. Wood is excellent, and this part of his book will be read and used by a far wider circle of readers than that for which it is primarily intended. Special reference may be made to his extension to fattening animals of the system of "rationing by performance," which is proving so successful in the case of dairy cows. This is a very real advance, for which all concerned with the difficult task of giving advice on practical feeding problems will be grateful.

The book is well produced and issued at a low price, and may be warmly commended to all agricultural students and others concerned with the feeding of live-stock.

Clockmaking, Past and Present. With which is incorporated the more important portions of "Clocks, Watches and Bells," by the late Lord Grimthorpe, relating to Turret Clocks and Gravity Escapements. By G. F. C Gordon. Pp viii + 232 + 35 plates. (London: Crosby Lockwood and Son, 1925.) 16*s* net.

To the makers and lovers of clocks this volume will be a welcome addition to their bookshelves. Though not intended to be a complete treatise on the subject, the author deals systematically with the materials, tools and mechanisms of clock-making and gives much excellent advice. The plates are a notable feature of the book, and though naturally most of them are devoted to various forms of clocks and clock cases, not the least interesting are those illustrating wheel-cutting machines, pinions and their collets, new and old screws, and the clock hands of various periods. There is one omission that should be pointed out On p. 58, when dealing with compensation balances, it would have been well to explain that the necessity for compensation arises mainly through the change in the elasticity of the spring of the balance due to alteration in temperature, and not through the variation in the dimensions of the balance.

There is a good chapter on the question of restoration and repairs to clocks and clock cases. In a short note on British clocks for export, the author offers some criticism of clocks sent abroad, and suggests that if the British Horological Institute were to issue designs and detailed specifications for three or four types of clocks, it would confer a great benefit on all concerned A bibliography is given containing some 80 or 90 books and pamphlets on clocks published since the appearance of Derham's "The Artificial Clockmaker" of 1696.

Around the Horn to the Sandwich Islands and California, 1845–1850. Being a Personal Record kept by Prof. Chester S Lyman. Edited by Prof. F. J. Teggart. Pp. xviii + 328 + 16 plates. (New Haven: Yale University Press; London: Oxford University Press, 1924.) 16*s* net.

PROF. C. S LYMAN was connected with Yale University for thirty-two years as professor of physics and astronomy and director of the observatory. He died in 1890 at the age of seventy-six. This book is the diary which he kept as a young man during several years in the Sandwich Islands and California. The long sea voyage round Cape Horn occupies only a few pages. His observations on the people of the Sandwich Islands are of value as a record of past conditions, and there is a good account of the volcano of Kilauea. Most of the diary has little scientific interest, though some of the descriptive matter is vivid. There are many interesting illustrations taken from old prints.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Exploded Ether.

THE idea of a universal physical æther seems to be getting terribly in the way According to Dr Jeans, in the Supplement to NATURE of March 7, p 362, "It was something more than a coincidence that Newton, Kelvin, Clerk Maxwell, and Faraday [the advocates of an æther] were all British, while Boscovich, Einstein, and Weyl are not" Descartes is not mentioned

One notices that the reason for supplanting Maxwell by Weyl is based on the original form of "Weyl's electromagnetic theory," which aims at absorbing electric fields into space—a theory which Einstein has steadily and consistently rejected, for the reason that its "two-foot rule" changes its length as it wanders through space, so that when it comes back to its starting-place it does not recover its original length, and (metaphorically) you don't know where you are.

Seizing on an idea of Eddington's, and utilising the Principle of Minimal Action, which is fundamental in physical formulations, Einstein has himself developed a theory analogous to Weyl's but he has to admit that it cannot in his hands explain electricity by atomic electrons It has, however, been claimed by another investigator that this can be got over by use of a widened foundation, and the question perhaps deserves further scrutiny by experts A quotation is here relevant, from Prof De Donder of Brussels, the most recent exponent of this interesting but very complex algebraic analysis. "En lisant les trois notes qu'Einstein a consacrées à la gravifique de Weyl-Eddington, on remarque que la confiance que lui inspire cette théorie va en diminuant C'est ce qui m'a conduit à lui demander son avis actuel, afin de pouvoir le communiquer au cours de mes conférences à la Sorbonne J'extrais de sa lettre (Leiden, 4, XII 1923) la phrase très importante 'Deshalb neige ich jetzt dazu, der ganzen theoretischen Entwickelung, welche auf einer Verallgemeinerung der Riemann'schen Metrik durch Verallgemeinerung der $\Gamma^{\sigma}_{\mu\nu}$ beruht, überhaupt keine *physikalische* Bedeutung beizumessen'"

If there is a distinctively British view of the æther, it is the one that was promoted, in his usual fragmentary and erratic manner, by Kelvin, the inspirer, along with Faraday, of Clerk Maxwell It identifies the æther as the substratum, with physical qualities, in which all matter subsists as a limited number of possible types of atomic structures, and which, moreover, binds these discrete atoms into a cosmos by their necessary interactions across it. Being the medium which makes atomic matter possible, it is not itself matter, and is not limited by any analogy to matter. It makes no essential difference whether one visualises it as an active physical medium or alternatively describes it as "space," or a "fourfold extension," endowed with physical qualities. The earlier analogies introduced waves of light and the electric field by contemplating displacement of the small parts of the æther, a varying displacement involving strain with its energy of elastic deformation. The newer representations become feasible through introducing the cognate notion of "parallel displacement" of the varying "space," as defined by the algebraic formulations of Prof. Levi-Civita. The relevant problem, as above indicated, is to carry the ideas through as far as possible, and so test the extent and appropriateness of their analogy with physical reality.

Fundamental space and time ought, one would think, to be uniform, the same everywhere As soon as the qualities of space are made to depend on the presence of adjacent portions of matter, it ceases to be pure space and becomes an interconnecting medium with physical properties But this subject, on its epistemological side, is far from having yet been exhausted. JOSEPH LARMOR

Cambridge, March 7.

Ether and Matter and Relativity.

IN the most valuable supplement to NATURE of March 7, through his Kelvin lecture to the Institution of Electrical Engineers, Dr Jeans gives a splendid summary of the present position in physics, showing how Lord Kelvin's "two clouds" obscuring the connexion of radiation and matter, instead of dispersing, have expanded to fill our scientific vision. Incidentally, Dr. Jeans makes it clear that in his view the terms ether and force are unnecessary, since all that they connote can be represented equally well by pure geometry, and indeed much better than by Lord Kelvin's curiously mechanical mode of attack. It is marvellous what hyper-geometry can be made to express, and what high reasoning about reality can be thus carried on But here comes the point I suppose that much the same can be said about the non-necessity of the idea of matter That too can be expressed geometrically, and apparently dealt with analytically, as the impenetrable centre of a warp in space, and as $G^{\nu}_{\mu} - \frac{1}{2}g^{\nu}_{\mu}G$, an expression which Prof. Eddington says behaves exactly like matter, except that it is more continuous than atomic, adding that the mind could scarcely recognise anything simpler as substantial and permanent ("Math Theory of Relativity," p 120) If relativists will grant that ether and matter can be *equally* dispensed with, a supporter of the ether need have no conflict with them. for ultimate questions about reality and existence can be left to philosophers.

OLIVER LODGE

March 10

The Source of Stellar Energy.

THE source of a star's energy is debated in recent letters by Prof. Lindemann and Dr Jeans (NATURE, Feb 14 and 28). Dr Jeans's conclusion is that the liberation of energy from the sub-atomic store occurs at a rate independent of temperature and density, and if one star liberates energy more slowly than another, it is solely because the former has exhausted the more prolific material. I think that there are grave astronomical objections to this view

First, it requires that the rate of emission of radiation by the star shall be very largely dependent on its previous history, whereas the astronomical indications are that it is so closely correlated to the present mass that there is little scope for outside factors. Consider, for example, two stars, each of which has radiated $\frac{1}{2}$ of its original mass, so that they are in the same stage of exhaustion: the first, originally of mass 3, is now of mass 1; the second, originally of mass 12, is now of mass 4. Their rates of radiation should accordingly be in the ratio 1 : 4; but both theory and observation seem to show that a star of mass 4 always radiates much more than 4 times as strongly as the sun

Secondly, this hypothesis seems to make the stars unstable. The energy E which is liberated must be

got rid of by radiation, and the radiation L is fixed by the mass and (to a comparatively small extent) the radius of the star. By hypothesis, E cannot be altered by a change in the physical conditions, so that the star must adjust its radius to bring L to the right amount. If initially $E > L$ the star is gaining energy and therefore expanding, the physical theory indicates that an increase of radius diminishes L, so that the discrepancy becomes worse. The star expands indefinitely.

The first objection is particularly evident when applied to the components of double stars which must contain material of the same age and, therefore, of the same degree of exhaustion. The hypothesis requires that these shall emit energy proportionately to their masses—a result which is not verified. The particular case of the sun and the earth is referred to by Dr Jeans, who meets the objection with a suggestion that the material forming the earth was not an average sample of the material of the sun at the time of separation. A short time ago I would have admitted this possibility; but I have recently found (in an article in the *Observatory* for March) that the rotation of a star must necessarily lead to circulatory currents in the interior which would keep the material well mixed. The argument is based on an extraordinarily general formula discovered by H. von Zeipel, and I do not think the conclusion can be evaded. It follows that when a star divides, each part has the same chemical composition, and if Jeans's rule were true the two parts would continue to be similar through all subsequent time.

It is very difficult to find a law of liberation which will satisfy astronomical requirements. In abandoning the contraction hypothesis we seem to have jumped out of the frying-pan into the fire—not that I see any conceivable prospect of returning to our former refuge. A direct dependence of the rate of liberation on density and temperature seems to be ruled out. On calculating the numerical magnitudes concerned (after taking into account all possible exhaustion-effects), it is found to give the star a kind of over-stability which would rapidly magnify the smallest disturbance into a large pulsation. This pulsation is supposed to occur in cepheid variables, but these are limited to a well-defined range of mass and density. With the hypothesis here considered cepheid variation would be more widespread.

At present, I see no insuperable objection to the following hypothesis, I scarcely recommend it in its present form, but some theory on these lines seems to be the one way out of an almost hopeless deadlock. We must consider two processes: one of evolution, the other of disappearance, of certain destructible forms of matter. The former is supposed to be dependent on density and temperature; the latter to be independent. It must be understood that the two processes are not the reverse of one another. The first is a transmutation absorbing or releasing comparatively little energy, the second is an annihilation of matter releasing great quantities of energy. The first is a synthesis involving the bringing together of constituents, its rate therefore depends on physical conditions. The second is a spontaneous degeneration in which only an isolated atom is concerned. The destructible elements are supposed to have lives ranging from a few minutes to many years, but most of the released energy comes from the long-lived products. A quiescent star will be in a steady state, except for the slow alteration of mass, the amount of self-destroying material and consequent generation of heat is thus dependent on temperature and density. Pulsation of the star will affect the rate of liberation only through the short-lived products; it should thus be possible to obtain stability without over-stability. It is necessary to admit exhaustion-effects also in this scheme, in order to reconcile, for example, the rapid liberation of energy in Capella with the slow liberation in the sun, notwithstanding the higher temperature and density in the latter.

I believe it is widely thought that the comfortable phrase *sub-atomic energy* ought to make the astronomer entirely happy, it gives him a long enough time-scale, and all is plain-sailing. Attempts to guess the *modus operandi* are regarded as mere speculation in an unlimited field. No doubt it is highly speculative to try to predict the processes by extrapolation of the modern theories of atomic physics, but the approach from the astronomical side is merely the prosaic procedure of empirically deducing unknown laws from observational data. Stellar astronomy is largely occupied with determining the rate of liberation of the mysterious source in conditions of temperature and density (both static and disturbed) which are now reasonably well known. Either the astronomer must leave this mass of data uncorrelated, or he must try to feel his way towards the disentanglement of the unknown agencies.

A. S. EDDINGTON.

Observatory, Cambridge,
March 4.

The Ages and Masses of the Stars.

CONCERNING Mr Schumann's comments (NATURE, January 24) upon Dr Jeans's paper (December 6) on "The Ages and Masses of the Stars," I should like to direct attention to the point of view expressed in my paper on "The Age of the Stars" which was read before the National Academy of Sciences on November 11 last, a few days before the meeting at which Dr Jeans presented his work to the Royal Astronomical Society. It was there emphasised that the decrease of mass as a result of radiation is a necessary consequence of the theory of relativity. If relativity be accepted this must be so, independently of the mechanism involved in the change of mass as *matter* into mass as *radiation*. The fact that a star radiates means that it loses mass in this way; whether all the mass lost is lost by radiation is another matter. My paper, which is to appear in the Proceedings of the National Academy of Sciences for February, goes into the point more fully than I can here.

EDWARD CONDON.

Physics Department, University of California,
February 14.

Late Palæolithic Art in the Cresswell Caves.

No one could welcome the results of Messrs Garfitt and Armstrong's exploration of Cresswell Crags more than I do myself, especially as they relieve the Palæolithic inhabitants of these islands from the unmerited reproach of an indifference to art. I only wish they had been made in time for recognition in the last edition of "Ancient Hunters."

In the light of these recent discoveries, the problem of the Cresswell "horse" assumes quite a different aspect, and I feel all the more bound to offer an explanation of the statement for which I am responsible, referred to by Sir W. Boyd Dawkins in NATURE of March 7, p. 336. It arose out of a conversation with the Rev. A. M. Mullins, rector of Langwith-Bassett, well known by his exploration of the Langwith Cavern, which is situated within easy reach of Cresswell Crags. Happening to refer to the almost complete absence of any artistic work in the Palæolithic deposits of this country, I mentioned

the famous horse as the only known exception to the general rule, when Mr. Mullins at once interposed with the remark, "And that is no exception," and proceeded to inform me that it had been introduced surreptitiously into the cave, more than one person—as I understood—having been involved in this nefarious proceeding. He demurred, however, and as I thought very naturally, to my request for names, but assured me that he spoke of his own personal knowledge.

Any reflexion on the good faith of any of the explorers of the cavern—particularly my old and dear friend the Rev Magens Mello, the actual finder of the engraving—would have at once aroused my indignant resentment, but there was no hint of this, and as Mr. Mullins's statement not only disposed finally of what I had always regarded as malicious gossip, but was also in general harmony with the state of knowledge at the time, I felt that I ought to make it public, even if only in a modest footnote

It is to be regretted that Mr Mullins is no longer with us to add his explanations to mine. All I can do now is to withdraw the controverted statement and to delete it from the footnote at the earliest opportunity

Perhaps I may be permitted to refer to another discovery which was made too late for notice in my last edition It is of great importance, since it affects not merely a locality but a whole industry I allude to the finding by M Peyrony in a Solutrean layer at Les Eyzies of a slab of limestone bearing a carving in high relief of two oxen (*Bos primigenius*) When I examined this last Christmas I was much impressed by its skilful modelling, fidelity to Nature, and artistic feeling It recalls, though less bold, the famous bisons of Tuc d'Audoubert

Hitherto the Solutrean age has afforded no objects of art, and this has always been regarded as a remarkable fact, for the Solutrean people were the first to introduce that new method in the working of flint which produced the most beautiful weapons of the Palæolithic age, and afterwards found its culmination in the wonderful productions of Neolithic Egypt and recent North America It was supposed in explanation that the Solutreans were a war-like invading race, who concentrated all their attention upon the perfection of their weapons, and had none left to bestow on purely artistic effort We now see how far this was from the truth. W J. SOLLAS.

University College, Oxford,
March 10.

Transmission of Stimuli in Plants.

MR. SNOW'S letter on this subject in NATURE of January 17, p 82, suggests the following considerations:

The fact that the velocity of the movement of coloured fluids in transpiring shoots and leaves is often much slower than the transmission of stimuli can scarcely be used as an effective argument against the rapid transport of hormones in the transpiration current. When a shoot, or leaf, is cut across and supplied with stain, the whole, or most, of the cross-section of its wood may be utilised by the current, and the velocity of flow may be comparatively slow; whereas, if the water transpired is made good through a conduit consisting of one or two tracheæ only, the velocity may be very great. It is significant that Mr. Snow himself attributes the transmission of a stimulus at a velocity of 52 cm. per minute to the movement of water in the vessels (Snow, R., Proc. R.S. B, vol. 96, p. 358).

Mr. Snow refers to his Experiment 11. In this experiment the wood of the petiole of a "stem and leaf preparation" was severed by a single cut of a razor. The tension of the water in the wood was relieved by the submergence of the preparation in water, and yet, after a rest of several hours, a stimulus was observed to be transmitted across the cut to the pulvinus It still seems to me possible that the movement of the motile tissue at the base of the pinnules forced water containing the hormone through the distal tracheæ and that some of this was drawn (really pressed by the atmosphere) into the tracheæ below the cut. The continued expansion of the cells adjacent to these tracheæ by turgor would give space for this movement. Thus relief of the tension might not preclude motion in the tracheæ

In any case, the experiment requires careful confirmation It appears from Mr. Snow's description that the experiment was attempted with 40 stem and leaf preparations The exact depth of cut required, just severing the continuity of the wood, was attained in only 5 of these. Of these 5, 3 showed no transmission of the stimulus across the cut The extreme difficulty of ascertaining with certainty, even with microscopic observation, that all the water-conducting elements were cut across, and remained severed during the experiment, may justify us in suspending our judgment as to the correct interpretation of this experiment

Mr. Snow also invites attention to his Experiment 12, in which he observed that exposing a narrow zone of a petiole to steam prevented the passage of a stimulus. In his paper he points out that both Haberlandt and Fitting obtained the opposite result. Furthermore, it is quite probable that substances introduced into, or developed in, the tracheæ by the heat may have prevented rapid motion of fluids in these capillaries

With some trouble I have succeeded in consulting, at Mr Snow's advice, Prof Herbert's paper in the *Philippine Agriculturist* It has disappointed me The details of the experimental arrangements are scanty throughout, and until more convincing evidence is produced I could scarcely agree with Mr Snow's statement—"The xylem of the petiole cannot conduct excitation downward at all, as has been shown by Herbert" In fact the latter emphasises more than once that, if the downward transmission is to be prevented, "a good deal of the wood" must be removed Further, when "dexylification" was practised by Herbert, he filled the cavity left by the removal of the wood with water. In this, of course, the hormone may have been transmitted, as in Ricca's experiments.

Mr. Snow quotes Bose as having showed that the phloem is the conducting tissue, by evidence derived from electrical changes Unfortunately the same investigator produces the same evidence in favour of transmission in the parenchyma on the inner side of the xylem, mistaking it for phloem To this tissue both Snow and Herbert deny the power of transmission HENRY H DIXON

School of Botany,
Trinity College,
Dublin

Indian Kala Azar Commission.

IN the issue of NATURE dated December 6, 1924, page 840, under a notice of the anniversary meeting of the Royal Society, mention is made of an investigation to be carried out under the auspices of that Society upon kala azar in India. The steady spread of kala azar in India has for long been a most disquieting feature in certain provinces. Recently, as a

result of the action of certain Provincial Governments in providing and encouraging treatment in the villages, the number of cases that have come forward has shown the disease to be prevalent, more particularly in Assam, Bengal, and Behar, to an extent hitherto unsuspected The number of cases treated has steadily increased as the benefits of treatment have become known, until the total for 1924 in Assam and Bengal alone has exceeded 100,000 treated cases But this probably represents only a portion of the actual incidence of the disease. There is reason also to believe that even in recent years kala azar has extensively invaded new tracts, *e g* whilst in 1910 only a few foci were to be found in Upper Assam, infection in the villages of the southern portion of this area is now almost universal There is no question, therefore, as to the menace of this disease, which has something of the relation to India that sleeping sickness has to Africa.

It may interest readers of NATURE to know that this state of affairs has received very serious attention in India, both in respect to efforts to cope with the fatal effects of infection by special measures for supplying treatment, and in regard to scientific investigation with the view of discovering the method by which the disease is transmitted Formerly kala azar was classed as an untreatable and almost necessarily fatal disease Since the discovery of the effect of tartar emetic in treatment, a large proportion of cases now yield to this drug, and the beneficent action of Governments in providing treatment has had an immense effect in the saving of life, though it has not apparently had any measurable effect in decreasing the incidence of kala azar, as was at one time hoped The scale on which treatment has been organised will be appreciated from the colossal total of treated cases already given, which represents for the greater part cases of kala azar treated near their own homes in the often remote infected villages, and cases which would otherwise have been unable to avail themselves of treatment even had the benefits of such been known to them. In Assam particularly, where the organisation for kala azar treatment has developed into one of the most remarkable efforts in ameliorative medicine in modern times, legislative measures have been freely taken, including an organisation for survey and notification and compulsory treatment where necessary The need for the latter, however, has steadily disappeared as the benefits of treatment have become known In addition, improvements in treatment which have largely originated in India promise in the future still further to rob kala azar of some of its terrors, for by the use of special antimonial compounds, *e g* urea stibamine, the percentage of successful treatments can be increased to include all but some 1·0 per cent of the 10-15 per cent of cases resistant to the ordinary method of treatment by tartar emetic. By the use of these drugs also the necessary period for treatment is reduced from a tedious period of three months to one of a month or less

Unfortunately, treatment of what is probably only a percentage of the actual number of cases, however effective to the individual sufferer, appears to hold out very little hope of preventing the continued spread of the disease, and effective preventive action can scarcely be successful until the method in which kala azar is contracted is known. The need for research on these lines has been all along appreciated in India, where, apart from the earlier work of Donovan, Rogers, Patton, Row, and others, there has been for the last ten years almost continuous investigation in the form of a Kala Azar Inquiry that has worked under officers well known as protozoologists and workers on insect-transmitted diseases. In October 1923 it was decided at the annual meeting of Research Workers of India that kala azar should receive attention as a priority research, and a draft constitution for a Kala Azar Commission was drawn up and submitted to Government. The Commission, financed by the Indian Research Fund Association and the different interested Provincial Governments, was constituted early in 1924, and has since been at work chiefly in Assam, where the facilities for the study of the disease are specially great In connexion with the Commission is an ancillary inquiry at the School of Tropical Medicine, Calcutta, constituted by Major R Knowles, I.M.S , Dr. L E Napier, and Assistant Surgeon R. O A Smith This inquiry, led by their previous epidemiological work to suspect either the sandfly (Phlebotomus), or the minute midges Culicoides, as the transmitters of the disease, were able to show that the parasite of kala azar develops with great certainty and ease in the sandfly *P argentipes*. The investigation of the relation of these insects to kala azar transmission is now taking first place in the researches of the Commission, who have already confirmed the results of the ancillary inquiry that sandflies of the above species fed on the peripheral blood of kala azar cases, in about 25 per cent of those fed, develop infections of the mid-gut with the flagellate form of the parasite These infections by the fifth day after feeding may be so heavy as to be comparable with the condition seen in culture and in natural infections with Herpetomonas

There remains, however, much to be done before the sandfly can be stated definitely to be the transmitting agent, for the method in which the parasite re-enters man is still unknown, nor has it yet been shown by experimental feeding or otherwise that infection can result in this way Extensive investigation is also necessary even when the carrier has been demonstrated before practical results can be achieved in prevention The Commission, though now working in Assam, will undertake researches in turn or simultaneously in other provinces, in order that full advantage may be taken of comparison of the conditions in as many areas as possible It is understood that the investigation under the Royal Society will in part at least be carried out in collaboration with this Commission, thus greatly strengthening and assisting the action already taken by India for the investigation of kala azar. S. R. CHRISTOPHERS.

Series Spectra of Two-valence-Electron Systems and of Three-valence-Electron Systems.

WE have recently been able to prove that the following laws first discovered in the X-ray field, namely (1) the Moseley law, (2) the regular-doublet, or Sommerfeld, law, and (3) the irregular-doublet, or Hertz, law, hold also throughout the whole field of optics, provided only the radiating atoms under comparison have the same electronic structure but varying nuclear charge.

We have further been able to obtain in our "hot-spark" spectroscopy long series of such atoms of like electronic structure, such as the seven stripped atoms Na I, Mg II, Al III, Si IV, P V, S VI, and Cl VII, a stripped atom being defined as an atom robbed of all its valence electrons save the one that, by jumping between the series of energy levels characteristic of the atom, gives rise to the observed spectrum (Millikan and Bowen, *Physical Review*, January 1924, September 1924, April 1925).

We have also found the foregoing X-ray laws, especially the irregular doublet law, powerful means for the interpretation of complicated spectra, *i.e.*, for the picking out of the lines due to particular electronic jumps in atoms in various stages of ionisation.

We have thus recently worked out and published the fairly complete spectra of a considerable number of stripped atoms.

In the present note we present the condensed results obtained by the extension of the same method to two more series of atoms of like electronic structure, namely, two-valence-electron systems, such as Mg I, Al II, Si III, P IV, S V and Cl VI, and three-valence-electron systems such as Al I, Si II, P III, S IV, and Cl V. The method of obtaining these results will be presented in detail in forthcoming articles, but the term values divided through in each case by the square of the effective nuclear charge are presented in the following-tables, from which, however, Cl V and Cl VI are omitted because not enough lines have been identified to permit of the complete working out of term values.

TABLE I

COMPARISON OF TERM-VALUES OF A SERIES OF ATOMS CONSTITUTING A TWO-ELECTRON SYSTEM, Mg I, Al II, Si III, P IV, S V

	N. R/N²	3. 12192·78	4. 6858·44	5 4389·40.
s	Mg/1	.	20474 5	9799·3
	Al/4		15147 3	7942·04
	Si/9	.	12962·5	7096·0
	P/16	.	11730 5	6592 5
	S/25		10923·0	.
p_1	Mg/1	39760 5	13820 0	7419·0
	Al/4	28570 3	11598·17	6535·34
	Si/9	24097 7	10522 5	
	P/16	21622·8	9864 1	.
	S/25	20019·9	9407·7	.
d	Mg/1	13714·7	7479·5	4704 1
	Al/4	14078 41	7595·02	4760 18
	Si/9	14121·4	7604 4	..
	P/16	14074·1	7583·2	
	S/25	13988·0	.	
f	Mg/1	.	6994 8	4469·0
	Al/4	..	7109 90	4603 27
g	Al/4		..	4419 45

TABLE II.

COMPARISON OF TERM-VALUES OF A SERIES OF ATOMS CONSTITUTING A THREE-ELECTRON SYSTEM, Al I, Si II, P III, S IV

	N R/N².	3. 12192·78.	4 6858·44.	5. 4389.40.
s	Al/1	..	22933·27	10591·58
	Si/4	..	16580·8	8462·9
	P/9	..	13944·2	7477·0
	S/16	..	12506·8	6908·2
p_1	Al/1	48168·87	15316·48	8003·24
	Si/4	32882·8	12643·0	..
	P/9	26974·7	11313·5	..
	S/16	23787·0	10489·0	..
d_1	Al/1	15844·15	9347·22	6043·31
	Si/4	13119·5	7700·0	..
	P/9	14050·0	7878·3	..
	S/16	14337·5	7884·5	..
f	Al/1	..	6962·6	4451·5
g	Si/4	19124·5	..	..
	P/9	15903·9	..	..
	S/16	16127·3	..	..

I S BOWEN
R A MILLIKAN.

Norman Bridge Laboratory of Physics,
California Institute of Technology, Pasadena.
February, 1925.

Losses of Ammonia from Soil by Volatilisation.

THE present communication is a preliminary note on the subject of the loss of volatile constituents from soil, which it is proposed to investigate in detail and on a large scale in the immediate future.

It has, of course, been known for long that while the growth of grasses and tree vegetation on an undisturbed soil produces increases in the nitrogen content of the soil largely owing to the activity of a series of nitrogen fixing organisms, the cultivation of a soil in which the nitrogen equilibrium point had been raised by quiescence invariably results in a loss which was not recoverable in the crop.

In this way there is a leakage of nitrogen which represents a serious economic loss. This occurs not only in Great Britain, but is even more pronounced in those countries where climatic conditions are such as to cause a very complete desiccation and aeration of the surface layer.

It was shown by Hall and Miller (*Journal of Agric. Science*, iv. 56) that when dishes of sulphuric acid were exposed above the soil there was a small absorption of ammonia which was supposed to come from the atmosphere. They observed that very considerable quantities of ammonia were given off from the soil as a result of an application of ammonium salts, and they conclude that "if the soil is palpably giving off ammonia during the months immediately following the ammoniacal manuring it must still be doing so at other times of the year."

It has been shown previously by one of us (Oxford Forest Memoirs, No. 2) that in those soils which contain large quantities of ammoniacal nitrogen there is a considerable portion of this which can be easily removed by solution in water, and further, that when the total amount of ammonia increases during desiccation, as is normally the case, the larger part of this increase is in a form in which it can be removed by water alone.

	Moist	1st Period	2nd Period	3rd Period.
Total ammonia	11 parts per million of dry soil	16	19	22
Water Soluble Ammonia	10 „ „	13	16	19
Solubility percentage	90·9 „ „	81·25	84·2	86·38

These figures show an increase in total amount of ammonia, which is largely composed of ammonia so little retained by the soil that upwards of 80 per cent. is removed by solution in water alone. The drying of these soils was carried out slowly and without aeration.

During the desiccation the increase of ammonia did not appear to be due to denitrification, as there was an increase in the nitrate content as well during the time of drying.

	Moist	1st Period	and Period.	3rd Period.
Nitrate	49 parts per million of dry soil	53	69	69
Increase as percentage of initial concentration	..	8·2	40·8	40·8

These results and others which arose in the course of an investigation into the presence of phenols in the soil, and the observations of Hall and Miller, already quoted, led us to carry out a series of experiments in which attempts were made to aerate the soil under different temperature conditions, and to determine whether any volatilisation of ammonia could be detected

The results of the first series, carried out with dry air at room temperature, are given below. The dehydration of the soil in these took place slowly

Soil	Crop	Season	P_H	Total NH_3	Soluble NH_3	Volatile NH_3	Moisture lost during Dehydration as per cent of Dry Soil
				p p m			
Forest	Isuga	Winter	5	5 7	2 1	1 45	30
,,	Corsican Pine	Spring	4	4 95	1 5	2	35
,,	Oak	Spring	7	2 4	8	8	30
,,	Larch	Summer	4	8 8	4 8	2	41

The second series were carried out with different soils and the aeration was effected by a current of dry air, the temperature of this and of the soil being maintained above 50° C

Soil	Crop	Volatile NH_3, Parts per million of Dry Soil.	Moisture lost during Dehydration as per cent. of Dry Soil
Egypt	Cotton	1 1	15
Chalk	Barley	·5	12
Marlstone	Pasture	5	31
V rich Hothouse		1·5	62

These figures again show a considerable amount of ammonia volatilised from the soil

An apparatus is in the process of construction which will deal with large quantities of soil, and it is hoped, will enable an extended series of observations to be made with soils of different types and at different temperatures.

G R CLARKE
C G T MORISON

School of Rural Economy,
Oxford

Robert Browning as an Exponent of Research.

I HAVE read with delight Mr Lamplugh's glowing appreciation (NATURE, February 28) of Browning's sympathy with scientific thought, and I agree with every word except that one searches vainly in "Paracelsus" for any clear appreciation of scientific research For more than forty years I have felt that that poem breathes throughout the very spirit of scientific enthusiasm which is the mainspring of research Paracelsus first "aspires"

> To contemplate undazzled some one truth,
> Its bearings and effects alone—at once
> What was a speck expands into a star,
> Asking a life to pass exploring thus

When he "attains" fame in the world he is struck with fear that his ideals may have declined with his lost youth and hopes, and exclaims

> . . . Would I were sure to win
> Some startling secret in their stead, a tincture
> Of force to flush old age with youth, or breed
> Gold, or imprison moonbeams till they change
> To opal shafts!—only that, hurling it
> Indignant back, I might convince myself
> My aims remained supreme and pure as ever!

In mature age he "aspires" again, looking back over more disappointments than triumphs, and the old passion swells up once more, struggling under the rein of reason

> And I betake myself to study again
> Till patient searchings after hidden lore
> Half wring some bright truth from its prison; my frame
> Trembles, my forehead's veins swell out, my hair
> Tingles for triumph. Slow and sure the morn
> Shall break on my pent room and dwindling lamp
> And furnace dead, and scattered earths and ores,
> When, with a failing heart and throbbing brow,
> I must review my captured truth, sum up
> Its value, trace what ends to what begins,
> Its present power with its eventual bearings,
> Latent affinities, the views it opens,
> And its full length in perfecting my scheme
> I view it sternly circumscribed, cast down
> From the high place my fond hopes yielded it,
> Proved worthless

Finally, when he "attains" to wisdom while dying in poverty and neglect, Paracelsus, "the searching and impetuous soul," reviews his career of discovery and traces the course of Nature from the time when

> The centre fire heaves underneath the Earth
> And the Earth changes like a human face,

and onward in a fine description of the origin of land, the advent of plants and animals and their development,

> Suggesting some one creature yet to make,
> Some point where all those scattered rays should meet
> Convergent in the faculties of man.

Surely this is not only appreciative but prescient also of scientific thought, for Browning wrote the poem in 1835 when Darwin was still sailing the seas, an unknown assistant-surgeon on the *Beagle*

HUGH ROBERT MILL.

February 28.

The Translation of Helmholtz's Physiological Optics.

THE reviewer of Helmholtz's "Physiological Optics" (NATURE, December 20, 1924, p. 887) remarks, "at last a deep reproach has been lifted from the record of English scientific literature."

Nearly quarter of a century ago (on returning from three years' work in a German scientific institution), I proposed to Messrs Longmans that I should write a translation for them to publish They agreed, and secured the services of Sir Michael Foster to edit the work, and bring it up-to-date. Sir William Abney and other scientists warmly supported the idea. The German publishers also were quite willing, and agreed to lend their clichés. The scheme fell through because the heirs of von Helmholtz, after long delay, refused to grant the rights of translation, acting on the advice of Prof. Arthur Konig. I forget the exact terms of König's letter, but it was to the effect that the book dealt with researches which had not been completed, and therefore it would be unfair to the memory of von Helmholtz to allow it to be presented to English readers as representative of his work.

ALICE EVERETT.

Teddington, Middlesex,
February 17.

The Historical Succession of Cultural Impacts upon South Africa.

By Prof RAYMOND A. DART, University of the Witwatersrand, Johannesburg, South Africa.

SINCE their discovery by the ivory trader Adam Renders (1868) the famous Zimbabwe ruins in Rhodesia have formed the rallying-point around which a fierce and even bitter controversy has raged amongst anthropologists and others. The central point at issue is whether these stately relics owe their existence to an endogenous civilisation, which has since vanished, or to an external and highly advanced culture the impact of which, though powerful, was gradually and ingloriously diminished at a remote historical period

The conflict which has proceeded about this issue has been valuable in causing suggestive data of considerable magnitude to be placed upon record It has revealed the existence of a stupendous enterprise in mining of gold, copper, tin, and pigments which involved virtually the whole territory from the Belgian Congo on the north to the Central Transvaal on the south, and from the Kalahari Desert in the west to the Portuguese East African coast in the east. These undertakings were prosecuted with a finesse which never fails to command the respect of modern engineers Rhodesia, the centre of the mining area, is found at the present time to be pervaded by extensive monumental remains in the form of monoliths, stone circles, and stone buildings, together with vast areas of terraced cultivation In many instances the buildings reveal a nicety of architecture and a regard for sanitation such as are not characteristic of Southern African natives. Moreover, the ornamentation and objects of phallic worship found in numerous sites have betrayed to many the influence of a people with artistic feeling, and with a complicated theology and religious ritual, who were probably Phœnician, coming from Sabaea in south-eastern Arabia

Important as the information at our disposal may be, we are far from an exact knowledge in any of the fields involved in this evidence There has been as yet no systematic anthropological survey of even a portion of the territory involved In the absence of detailed and precise data, it has been easy for ill-informed argument to accumulate and the significant issues to be overwhelmed in a sea of conjecture.

It is at this juncture that the painstaking and tireless investigations of a Trappist monk of the Marianhill Monastery in Natal appear to provide decisive information such as has been so long searched for Equipped with the knowledge of an artist skilled in reproducing and retouching medieval works of art in the Cathedrals of Cologne, Bonn, and elsewhere, Brother Otto has been copying with infinite patience for some years the Bushman paintings found in the rock shelters of the Kei River Valley, in the eastern portion of the Cape Province. Copies of certain of these he has forwarded to me with notes for the purposes of this article.

Bro. Otto is not the first investigator who has worked in this region. Stow visited a number of the caves here; and another priest, P. M. A. Schweiger, R.M.M., published (*Anthropos*, 1913) certain of the paintings which Bro. Otto has since studied more minutely. It has remained, however, for Bro. Otto to reveal the historical significance of these works of art.

In the first place, Bro. Otto believes he is able to prove that the art of painting was indigenous to this country, and was not introduced from outside. The works which illustrate the beginnings of the art are crude drawings in charcoal, chiefly of animals, and later of naked human forms revealing the well-known Bushman characteristics. Apparently, by experimenting with pigments mixed with the juices of the Euphorbia flora, works were executed with exceedingly fine brush technique The pigments, of which a considerable variety was utilised, seem finally to have been rendered impervious to the passage of time and the most rigorous climatic exposures by the discovery of the value of oil as a medium, until latterly the finest works were executed indifferently in the recesses of shelters or on the weather-beaten faces of the rocks outside

These matters are important enough, but a greater human interest attaches to the discovery that, after their technique had become perfected, the Bushman found subjects for artistic exploitation in voyagers who visited their coasts and inland rivers at a period



FIG. 1.—Bushman painting in deep red monochrome, in a cave near the confluence of Ngolosa and Kei Rivers. (After Bro. Otto.)

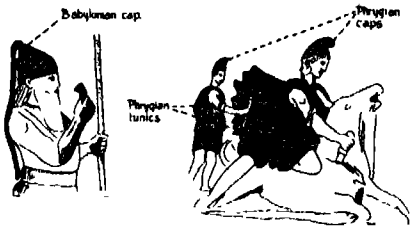
so remote in time that paintings depicting them are sometimes found to be partially covered by an incrustation one-sixteenth of an inch in thickness

From twenty-eight separate sites over an area twenty miles in length along the Kei River, Bro Otto has collected more than two hundred and fifty copies of painted groups, and has not omitted, to his knowledge, any detail depicted by these primeval artists within this circuit From this mine of material he is in a position to provide authoritative information concerning the homeland of these visitant navigators of early times.

A picture from a cave near the confluence of the Ngolosa and Kei Rivers in the Cape Province is represented in Fig. 1. Here we find the figures of two naked Bushmen, and of two foreigners—gigantic in the Bushman's estimation, and wearing ancient Asiatic tunics and headgear The painting depicts a scene in which a piece of clothing is about to be cast over a nude Bush maiden by a bearded man dressed in a Phrygian tunic and cap, and carrying a weapon (sword ?). Opposition is expressed in the antagonistic attitude of the naked Bushman, who carries a stick in his hand, while the operations are followed closely by the other massive figure, also clad in a tunic, but

wearing a cap of Babylonian design. This figure has no weapon, and is presumably that of a merchant captain. Other pictures of similar alien intruders show them to be usually bearded and armed with bows and arrows, shields, and other weapons—swords and javelins,—whereas the Bushman in these old pictures is generally unarmed or is armed only with a stone or a stick It seems possible from these facts that the Bushman learned the use of the bow from such visitors

It is amazing to find that the clothing and headgear



FIGS. 2 and 3.—On the left, figure of Marduk, original in the Berlin Museum (After Birkner, "Rassen und Völker.") On the right, Mithras slaying a bull, original in the Louvre, Paris (After Hochland)

of the people depicted in this painting have their counterpart upon the bas-reliefs of Babylonia and the ancient paintings and sculptures of the Mediterranean area (see Figs. 2 and 3).

It is perhaps equally remarkable that no inferences have been drawn from pictures already published similar to those in the possession of Bro. Otto. More than twenty years ago there appeared in the "Natal Railway Guide" (1903, p. 216) a picture (Fig. 4), photographed in Natal by J. E. Middlebrook, which presented the same striking juxtaposition of naked Bushmen and clothed Asiatics of the Babylonic-Phœnician period. This photograph was reproduced for the purposes of an article by D. Waterston in the *Scientific American* (1915, p. 191). In the meantime, as mentioned already, another priest, Albert Schweiger, had published (*Anthropos*, Bd. VIII., 1913) numerous pictures portraying the presence of clothed foreigners

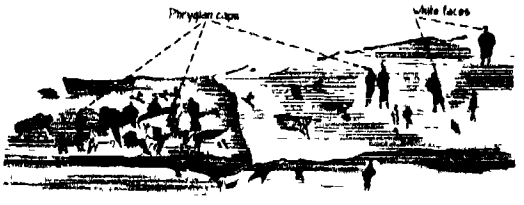


FIG. 4.—Bushman painting from Natal revealing contact of Phœnicians with Bushmen (After photograph from the "Natal Railway Guide," 1903, and *The Scientific American*)

which were gathered in the same area as that examined by Bro. Otto. A copy of one of these paintings (Tafel XI.) showing a Babylonian type of cap is shown in Fig. 5.

Pictures showing clothed foreigners are also to be found in the classical work of Miss Helen Tongue ("Bushman Paintings," Oxford, 1909). This author has published many plates of paintings copied in the eastern part of the Orange Free State and Cape Province. Plate XV., No. 102, of her work presents a "procession of men and women dressed in cloaks." The faces of the members of the procession are painted white—a feature of no small significance when it is recalled that Bushmen generally represented themselves and other African natives by means of a black or a scarlet pigment. Bro. Otto's experience agrees with that of Miss Tongue and of J. E. Middlebrook (*vide* Fig. 4) in finding the features of these alien personages depicted usually by means of a white pigment.

We have seen, then, from the independent evidence of at least four people, that foreigners who were clothed in Phœnician and even Babylonian garb were well known to the aboriginal Bushmen of the Eastern Cape Province, Orange Free State, and Natal. But perhaps the most beautiful reproduction of a Phrygian cap was discovered by Father Krauspenhaar a thousand miles north of this region, in Rhodesia, at Rusapi, which is situated on the Beira–Salisbury railway some two hundred miles inland. Fig. 6 is a drawing of Father Krauspenhaar's copy of this picture.

In a portion of the same area (Barkly East) as that examined by Miss Tongue are many pictures of clothed and capped Phœnician foreigners, some of which have been reproduced in Dr. O. Moszeik's "Malereien der Buschmänner" (Berlin, 1910, pp. 61 and 66). Barkly East is situated on a tributary of the Orange River

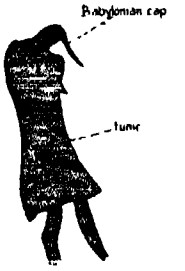


FIG. 5.—Bushman painting from "Nthintshi near Kei River, Cape Province, depicting a foreigner (Schweiger)

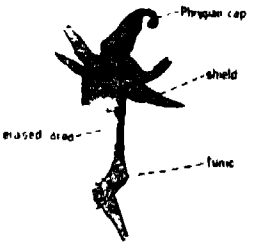


FIG. 6.—Bushman painting in monochrome red from a cave near Rusapi, Rhodesia (After P. F. Krauspenhaar.)

nearly two hundred miles inland, and consequently we are now in a position to state that the whole of the eastern portion of the African continent for some hundreds of miles inland, which lies between the latitudes of the Zambezi on the north and the Orange and Kei Rivers on the south, was exploited by the *old-colonists*, as Bro. Otto terms them, from South-west Asia in remote ancient times. He calls them *old-colonists* because he believes he is able to prove conclusively from the paintings that these very ancient voyagers not only visited these territories and carried off their denizens, particularly their women, but also intermarried with them and settled down amongst them, bringing to them novel arts and customs (Fig. 7).

The significance of these observations for the unravelling of the Zimbabwe riddle is not far to seek, for they reveal the unsound nature of Randall MacIver's theory of medieval and even Bantu origin of the ruins, mines, and agricultural terraces south of the Zambesi. The pictorial art of the Bushman has preserved through the lapse of centuries unassailable evidence of the impact of ancient civilisations of the Eastern Mediterranean and Mesopotamian areas upon a Bushman South Africa which betrayed in their day no evidence of Bantu contamination.

One of the supposedly crucial pieces of evidence

adduced by MacIver in support of his hypothesis of a medieval Rhodesia, the culture of which was of purely Bantu origin, was the constantly recurring discovery of Chinese porcelain in these ruins. The presence of this ware was rather naturally attributed to Portuguese influence. But the Chinese were navigating the Indian and Pacific oceans in luxurious fashion in the days of Marco Polo, when the Princess Kokáchin went by sea from China to Persia. Nearly three centuries before Marco Polo's time, Alberuni (about A D. 1030) records that "The reason why in particular Somanâth (in India) has become so famous is that it is a harbour for seafaring people, and a station for those who went to and fro between Sufâla in the country of the Zanj and China" (E. C. Sachau, 1910, vol. 2, p. 104) Indeed, the timid writer of the Periplus found his way south along the African coast so far as Rhapta in the first century of our era, and relates of Arab captains and agents at that period "who are familiar with the natives and intermarry with them, and who know the whole coast." There is every reason for believing that

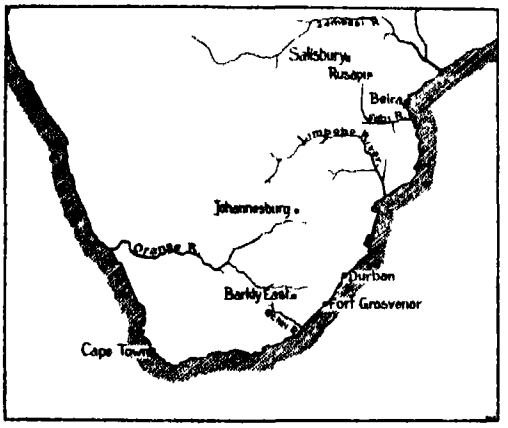


FIG. 7.

in the early centuries of the Christian era, and perhaps prior thereto, when Chinese arms were pushing far westward upon land, Chinese shipping was contesting with Indian and Arabian vessels the trade of the East African coast, which had already fallen from the hands of Egypt and Mesopotamia and those who brought and carried for these countries.

Fig. 8 is a copy of Miss Helen Tongue's Plate XVIII., No. 27, of which she states that "the whole appearance of this painting is ancient." The present interest lies in the fact that it portrays a man of light brown complexion, adorned with two necklaces, arrayed in sumptuous apparel, and carrying on his head a peaked Chinese hat. Bro. Otto has also discovered a number of pictures (*e.g.* Figs. 9 and 10) showing this unexpected type of headpiece. In the light of all these facts it must be recognised that MacIver's hastily drawn conclusions are utterly inadequate to explain the ethnological problems of the southern end of this continent.

That Rhodesia was brought into contact directly with Arabian and Indian agricultural products is shown by the fact that vines, lemons, figs, and cotton, though not indigenous to South-east Africa, are found on the terraced hills of Inyanga in Rhodesia. "Livingstone, Chapman, Burton, Kirk, and all authorities on Zambesia down to the present day have called attention to the great number of plants, fruits, and trees of Indian habitat to be found together on the Rhodesian gold-mines area. These are, of course, not indigenous to this country: the now wild *Tonge manga*, a cotton of Indian origin, not the *Tonge cadja*, which is indigenous, also a bean, *Cajanus Indicus*, known in India as the Dhal Plant, the Indian fig, grown wild; and a tree, *matuvi*, found elsewhere only in India There is also the *Mahobohobo*, which has its habitat only in Southern India and Malaya In Rhodesia this tree is only found on the area of the prehistoric rock mines, but the vast extent of the country now covered by its forests demonstrates that it arrived in some exceedingly remote time" ("Guide to Rhodesia," 1924).

Whether Chinese pottery reached Rhodesia by a European or, as is more likely, by a more direct route past India and Arabia, the discovery of it affords us little light upon what was taking place in Southern Africa long before European and even Indian and Chinese contact was possible; and it is precisely here that the evidence accumulated by Bro. Otto is of premier significance, seeing that it demonstrates an extremely ancient cultural impact upon the aboriginal Bushman

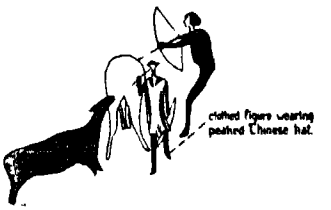


FIG. 8.—Bushman painting in light brown and dark brown, from Magdala, near Barkly East (After Miss Tongue)



FIG. 9.—Bushman painting on a stone block, Ehweni, Kei River, depicting a foreigner



FIG. 10.—Bushman painting in black from cave on the White Kei River, Cape Province, depicting a foreigner

These remarkable pictures also bring into their proper perspective a series of discoveries of a different but allied nature which have been inadequately appreciated hitherto.

About fifty years ago, Mr. Thomas Cook, who is still living in Durban, discovered twenty-eight coins in a calabash at a depth of about six feet, on the site of a native hut, near the beach at Fort Grosvenor in Eastern Pondoland. Many of these were so worn that their inscriptions were illegible—illustrating that they had been much handled—but some, which were legible, were described by Mr G. F. Hill, of the British Museum, in the *Classical Review* (of 1897 or 1898). The oldest three coins were of the period of Ptolemy I, II., and IV. respectively (*i.e.* 304–204 B.C.), and the other coins examined were Roman coins issued between the dates A.D 296 and 313, five of them being struck at Alexandria, two at Antioch in Syria, and one at Cyzicus.

This discovery is not the only one of its kind, for when the monks were building their water reservoir at Marianhill, twenty-six miles from Durban, they found, at a depth of eighteen inches in a recent stratum

of sand and humus on the side of a hill, a Hebraic coin of the reign of Simon Maccabæus (143–136 B.C.), with the inscription "fourth year of the deliverance of Sion" (*Anthropos*, Bd. V., 1909, p. 168).

Now it is conceivable that stray Egyptian, Maccabæan, Syrian, and other coins might percolate even to extreme Southern Africa without any intense cultural movement being afoot; but coins generally signify commerce, and the most cursory examination of any map of Africa south of the Zambezi will show that Palestine and Arabia—those homes of commerce—have left behind very clear evidence of a lengthy contact with this part of the globe. It is by no accident such as might conceivably determine the movement of coins, nor by any philo-Semitic proclivities of the Portuguese, that we find in Portuguese East Africa and the countries adjacent thereto place-names such as Antiocha, Jacobecua, Jacoja, Jacota, Gadsane, Gadzema, Jofane, Gaza, Gizha, Sinoia, Jobo, and the like. The two rivers Sabi and Sabie as well as Lake Sibai, together with Sabia, Sabetsi, Sebaba, Sebakwe, Shebekwe, Shibuto, Shibabara, Chabane, Chiba, Chibi, Chibambala, Chibababa, and so on, owe their names to a people fascinated by the central root Saba, Seba, or Sheba, just as the Dutch have left in South Africa their "fonteins" and "burgs," the English their "Londons" and "Cambridges," and the Scotch their "Dundees" and "Glencoes". So, too, Masibi, Mazibi, Mazibila, Masipe, Mripa, Mriba, and Mareba have an intimate relation with Marib, in the same way as Mocuba, Mokuba, Mkubi, Namoko, Makiki, Muchacha, Machiche, and Machacane recall the Arabian Mocha.

In brief, the themes for the variations provided by hundreds of place-names south of the Zambezi lie in the Asiatic continent, and still await the investigations of specialists in this field. The evidence to be culled from this study will be especially valuable in "dating" and "placing" the different cultural intrusions. Many of the Arabian names are undoubtedly pre-Koranic. In addition to names from Western Asia, there are Indian types such as Ricatla, Mandle, and Kande, and variants of the old name of Japan (Zipangu), namely, Chipanga and Chipinga. I have entered into this matter of place-names in some detail because, rich as the field obviously is, I am not aware of any serious study of this sort made hitherto upon this locality.



FIG. 11.—Bushman painting from "Ngolosa" (Kei River), revealing Egyptian characters in clothing and head dress. (After Schweiger.)

We have considered already evidence which indicates that, prior to the coming of the European, not only mediæval Arabian, but also Indian, Chinese, pre-Koranic Arabian (Himyaritic-Sabaean), Palestinian, Phrygian, and even Babylonian influences have played a part in moulding the destinies of the primitive peoples of Southern Africa. There are not lacking evidences that Egypt, too, was in intimate contact with this remote region. There is one picture of Schweiger's from the Kei River Valley (Fig. 11), in which the head-dress, clothing, and artistic feeling is positively Egyptian. However, I would have disregarded this picture if I had not been arrested while in Marianhill by the persistence of the same Egyptian fashions of head-dress amongst the native women at the present day. The photograph reproduced in Fig. 12 reveals Egyptian characters not only in the head-dress



FIG. 12.—Native women, Marianhill, Natal, showing Egyptian characters in head dress and clothing.

and the head-ring, but also in the clothing (suspension at the waist, fringe at the lower margin), and even in the features of one woman; the other looks Semitic, but neither is frankly Negroid or Bushmanoid. For comparison with Figs. 11 and 12, I have reproduced one of the figures in the procession of servants of the Queen Hatshepsu who visited the Land of Punt (Fig. 13).



FIG. 13.—Figure in procession of Queen Hatshepsu's servants, to illustrate Egyptian head-dress and clothing.

In this connexion, it will be recalled that Dr Karl Peters discovered (Keane's "Gold of Ophir") in Rhodesia a figurino of an Egyptian courtier—of the period of Thothmes III. (Dynasty XVIII.)—holding in his hands the scourge of a slave-driver. Further, most authorities concur in believing that the steatopygous Queen of Punt and her daughter portrayed in the spoils of the voyage of the sister of Thothmes III., Queen Hatshepsu's (1501–1479 B.C.) servants to the divine South-land, was a Bushwoman or closely related to one. Thus Sir Flinders Petrie ("History of Egypt," vol. 2, 1899) says, "The strange fatness of the queen has been much speculated upon; whether it was a disease such as elephantiasis, or was natural fat, has been debated; but as her daughter shows much the same tendency of

curve in the back, it is probably the effect of extreme fat, which was considered a beauty, as in South Africa at present." Rawlinson (*Ancient Egypt*, 1893) is still more emphatic when he states, "She belonged, more probably, to one of the dwarfish tribes of which Africa has so many, as Dokos, Bosjesmen, and others."

The land of Punt is generally supposed to have been south-eastern Arabia or some point along the southern Somali coast; the spices, resins, and incense products being in favour of the former; the giraffes, ivory, cynocephalous apes, and the like speaking for the latter. Frobenius ("Das unbekannte Afrika," 1923) has shown in a map the distribution of houses on piles such as were seen by these voyagers to Punt. None such are to be found in Arabia or Somaliland, but they are found on the big rivers of Africa southward from Somaliland. Resins and snuffs have the highest of values amongst the Bush people even in modern times I do not say that the data are conclusive to prove that God's land, Punt, lay in Africa south of the Zambezi, but the facts are highly suggestive The products of the country--people, animals, gold, resins, pigments, and the like--were such as this country certainly was affording in plenty at that remote period At the same time, it is a well-recognised fact that for centuries, perhaps millennia, prior to Queen Hatshepsu, ships had been navigating the Red Sea, the open ocean, and the Persian Gulf between Egypt and Mesopotamia. It is not reasonable then to imagine that the Egyptian queen would render herself a laughing-stock before the civilised world by celebrating in the building and decoration of a new temple as extravagant marvels the products of places near by like the coasts of Arabia and Ethiopia. To fit out an expedition for this remote South-land of Punt was always an epochal event, and was carried out only by the greater Pharaohs in times of peace and prosperity, and was even then worthy of record. Such expeditions are recounted in the times of Sankh-ka-ra (Dynasty XI.) under the nobleman Hannu, of Hatshepsu, of Thothmes III.—the Napoleon of Egyptian history—and of Horemheb (all three of Dynasty XVIII.), and of Rameses III. (Dynasty XX.). It is absurd to believe that these proud names in Egyptian history would reckon trips to little beyond the mouth of the Red Sea as worthy of mention when the equipment of voyages three years in duration were commonplaces in the chronicles of the pigmy court of Solomon. Even in the humdrum days of Herodotus, one circumnavigation of Africa had not been entirely forgotten, for he relates how King Necho's Phœnician servants had accomplished this hardy feat.

His Honour the Administrator of the Transvaal (Prof. Jan H. Hofmeyr) has informed me that the remains of what was presumably an ancient galley were discovered during the laying out of the Maitland Cemetery on the Woltemade flats near Cape Town in the 'nineties. At that time the contact of one end of Africa with the other by navigation was undreamt of, and the significance of finding a boat, one hundred and eighty feet in length, buried six feet underground at a distance of three miles from the present coast-line, was lost on the workmen, who utilised it for firewood The event at least indicates that the followers of Prince Henry were not the first to anchor in Table Bay

The continuity of the Atlantic and Indian Oceans around the southern extremity of Africa was customarily portrayed by the ancient cartographers of Greece (*e.g.* Globe of Crates), of Arabia (*e.g* Idrisi), and of Europe from Venice to Anglo-Saxon England (*vide* "Encycl Britt.") It is difficult to understand how such conceptions could have grown up and persisted in this fashion unless the experiences of ancient voyagers had provided some foundation for them. It is likely that the voyage of Necho's servants was but a repetition of many similar ventures in the storied past In any case the tale provided by Herodotus is more easily believed when we know that Bushmen from the Zambezi to the south-eastern corner of the continent on the shore-coast and for hundreds of miles inland have recorded in portrait the arrivals and the activities of not merely one but untold numbers of invaders at successive historical epochs.

It is not in the contact of any one people but in the endless procession of emissaries of every great navigating power in the Indian Ocean down this coast that one finds an explanation of the prodigious extent of the early mining industry of Southern Africa. Moreover, it is only in terms of this procession that the physical, anthropological, and ethnological problems of this country can be adequately understood. It is impossible here to do more than direct attention to certain aspects of these intricate but highly fascinating studies. It has already been stated that no exhaustive anthropological survey of the region concerned has been made; but if the urgent necessity for such a survey of the paintings, ruins, terraces and mines, and the nature and richness of its prospective fruits, are indicated, these meagre notes will have been justified.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

12. ESMATT EFFENDI.

I AM not aware that any publication of Esmatt Effendi has ever seen the light of day, but nevertheless my readers, I hope, will agree that his name deserves to be included in this collection of reminiscences. He certainly possessed two essential qualities, enthusiasm and perseverance. I made his acquaintance at Suez, on the evening of May 3, 1882, when, on behalf of the Khedive of Egypt, he received a party sent out under the auspices of the Royal Society to observe the total eclipse of the sun that was to take place on May 17 at Sohag, some way up the Nile. He gave us a very promising account of the local facilities, more especially with regard to bricks and mortar for the foundations on which to place our telescopes; and if his predictions did not come true, and the only brick we saw was that aimed at the head of one of the party by an inhabitant of the village, his intentions were undoubtedly good

Esmatt Effendi had an ambition to learn something about astronomy, and showed great interest in a

[1] Continued from p. 385.

sextant that I had taken out to check our chronometers. He begged me to teach him its use. After a few lessons, I found him one day trying to find the image of the sun in an artificial horizon, having pushed all dark glasses out of the way. I had warned him against this, and got rather angry with him He replied, "I am an Egyptian, and I cannot see the sun with the dark glasses. When an Egyptian says he is going to do something he is going to do it, and I am going to see the sun through this sextant even if I lose my eyesight" I had to lock up the sextant

It was some years before I heard of Esmatt again. Through diplomatic influence, the Naval Observatory at Washington had been persuaded to take him in as a kind of apprentice They found him, as I had done, persevering and enthusiastic, but incapable of assimilating any knowledge They tried to persuade him to return home and take up some other occupation, but Esmatt Effendi had made up his mind to stay The authorities of the Observatory learned afterwards that all the time he was half starved, and had to sell his books and a great part of his clothing to pay for his board and lodging Matters ultimately reached a crisis and he was told to leave He finally consented, on condition that the authorities would give him a testimonial which would enable him to find a position at home They considered the matter, and ultimately resolved that it was worth while to stretch a point, and they sent him the requested testimonial To their surprise, they found Esmatt again at his desk next morning. He was reminded that they had kept their part of the bargain and that he must keep his. Esmatt stood up, took the testimonial out of his pocket, waved it in front of their faces, and said, "The man who deserves this testimonial deserves to work in the Observatory of Washington." The rest of this story, which I give on the authority of one of the principal astronomers concerned, must be left to the imagination.

Conclusion.

It is with some hesitation that I conclude these reminiscences with the account of an incident that revives painful recollections, and the publication of which I should, for obvious reasons, have preferred to be left over until after my death It concerns a distinguished personality whose memory is cherished by many friends, but their ranks are now rapidly thinning, and for this reason I feel compelled to disregard personal considerations.

Early on during the War, I was one morning surprised to find paragraphs in the daily press implying that a wireless apparatus had been found and "seized" in my house, with more or less veiled references to the purpose for which the apparatus was likely to have been erected. The complete story may be told some day; at present it is sufficient to say that I do not blame the newspapers

Though I knew that the implied accusation was not likely to impress my friends, the matter, in view of my position at the time, was serious, and it was with fear and trembling that I entered the Athenæum a few days later and selected a solitary place in the coffee-room. I was leaving again directly after luncheon, and as I was putting on my coat in the hall I suddenly felt some one stepping up behind to help me. Surprised at this politeness, which is somewhat unusual in the Club, I turned round and looked into the kindly face of Lord Roberts, with whom I had no personal acquaintance The hall was then full of members of the Club, and it was obvious that the action was intended to be, and in fact was, a demonstration. Such incidents are not likely to be forgotten.

Obituary.

Prof. W. A Haswell, F.R.S.

THROUGH the death of Prof. W. A. Haswell, at the age of seventy-one, zoology has lost one of its foremost exponents, and the University of Sydney a teacher and investigator of world-wide reputation.

William Aitcheson Haswell was born in Edinburgh in 1854, and was educated at the Edinburgh Institution and the University, where he gained the Bell-Baxter Scholarship as the most distinguished natural science graduate of his year. As quite a young man he went out to Australia and, settling down in Sydney, there spent the rest of his life. In 1880 he held the post of curator of the Queensland Museum. Then, returning to Sydney, he delivered public lectures on zoology, and became in 1882 acting curator of the Australian Museum, and published his valuable Catalogue of the Australian sessile- and stalk-eyed Crustacea. In the same year he was appointed lecturer in zoology and comparative anatomy in the University of Sydney, under Prof W J Stephens, who at that time held the chair of natural history. Young and enthusiastic, Haswell threw himself with great energy into the study of the rich fauna of Port Jackson and the adjacent coasts, and in the course of a few years published, in the Proceedings of the Linnean Society of New South Wales, numerous papers, mainly of a systematic character, on the Crustacea, Annelida, and Bryozoa of the Australian seas In particular we owe to Haswell the first description, in 1882, of the giant Phoronis that occurs in Port Jackson, which he named *Ph. australis*, and in the same year he exhibited drawings of the early stages of its development before the Linnean Society.

During this period, however, Haswell by no means confined himself to invertebrate zoology, but contributed to the Linnean Society valuable papers on vertebrate morphology, on such diverse subjects as the anatomy of birds, the structure of the paired fins of Ceratodus, the skeleton of elasmobranch fishes, and the early stages of the development of the emu (1887). He also described in 1886 in the *Q.J.M.S.* the remarkable striate muscle fibres in the "gizzard" of the polychæte worm Syllis, and in 1889 published a very interesting comparative study of the same fibres. In 1888, also in the *Q.J.M.S.*, he gave the first detailed account of the anatomy of that remarkable ectoparasitic trematode, Temnocephala, a form which will always be associated with his name.

Such was the reputation Haswell had established for himself as an original investigator and teacher that the Senate of the University of Sydney, when the

Challis professorship of biology was instituted in 1889, appointed him to the chair, without advertisement—at the time a most unusual proceeding—and this he held continuously until his retirement in 1917. All through these years his scientific activity continued unabated.

In 1893 Haswell published, in the Macleay Memorial Volume, his great monograph on the Temnocephaleæ, a group which occupied his attention right up to the end of his working days, for the last paper he wrote is entitled "Critical Notes on the Temnocephaloidea," and was published in the Proc. Linn. Soc. N.S.W. so recently as December 29, 1924. In the volume above mentioned he also described the remarkable new type, Actinodactylella, from the gill-cavities of the Gippsland burrowing crayfish, *Engæus fossor* In numerous papers, published mainly in the *Q J M.S* and the Proc. Linn. Soc N S W., he contributed largely to our knowledge of the Turbellaria, both fresh-water and marine, and the Cestoda, and by his discovery of the histriobdellid, Stratiodrilus, and his detailed accounts of its anatomy and development, he greatly extended our knowledge of the "Archi-annelida," whilst to him we are indebted for the only available account of the early development of the Port Jackson shark (Heterodontus).

Outside the ranks of professional zoologists, Haswell is perhaps best known to the scientific world as the joint-author, with his staunch friend the late Prof. T. Jeffrey Parker, of the monumental "Text-book of Zoology," which, issued in 1898, is now in its second edition and is accepted as a standard text-book in zoological laboratories all over the English-speaking world.

Amidst all his academic work Haswell found time to take an active interest in the various Australian scientific organisations He was for long on the Council of the Linnean Society of N.S.W, and acted as its president in 1892–93; he was president of Section D of the Australasian Association for the Advancement of Science in 1891, and he was for many years a trustee of the Australian Museum. In 1916 he edited the Reports of the Australasian Antarctic Expedition

Haswell was a man of wide knowledge and culture. Shy and somewhat reserved in disposition, he was a loyal, warm-hearted, and ever helpful friend and a kindly and charming host. He was a keen trout-fisher, enjoyed a game of golf, and was an ardent gardener. In 1894 he married Josephine Gorden Rich, a pupil of Jeffrey Parker and joint-author with him of a paper on the myology of Palinurus, and she always took a lively interest in her husband's work. She and an only daughter survive him.

Haswell was elected a fellow of the Royal Society in 1897, and was a member of numerous societies both at home and abroad.

The writer will ever bear his old chief in grateful memory for the forbearance and many kindnesses he showed him during an association of some fourteen years. J. P. H.

PROF. JOHN CLELAND, F.R.S.

PROF. JOHN CLELAND, who died on March 5, in his ninetieth year, held the chair of anatomy in Queen's College, Galway, from 1863 until 1877. In the latter year he succeeded Dr. Allen Thomson as occupant of the chair of anatomy in the University of Glasgow, which he held until 1909, retiring at the age of seventy-four to spend the happy evening of his days at Crewkerne, Somerset.

Cleland was a man of imposing appearance who impressed on the generations of students who passed through his class-rooms his love of knowledge, his wide culture, and independence of outlook He was beloved by his students. All his life long he was fighting a rear-guard action. He was born and bred in pre-Darwinian days and grew up in the school represented by John Goodsir and Richard Owen He believed in evolution—particularly the brand represented in the "Vestiges of Creation." He could not abide the dogmatic assurance with which Huxley proceeded to sweep the "underlying element of spirit" from all biological processes For him Darwin's law of "Natural Selection" was true and potent, but in his opinion this law was powerless in the production of purposive adaptations He was a student of "morphological design" and believed that a "unity of cause" worked through "the ordered sequence to be seen in all biological events." The "morphological beauty of the skull" was almost one of his religious tenets Those who know the researches and writings of John Goodsir will realise how strong was the influence which the master exerted on John Cleland seventy years ago. With him goes the last representative of the transcendental and philosophical anatomists of the nineteenth century.

Cleland was born in Perth in 1835, the son of a medical man He was turned from the Church to medicine by his mother, and began his studies in the University of Edinburgh in 1852. Goodsir, then a man of thirty-eight, was at the height of his fame and immersed in researches of the most diverse kinds, but was particularly enamoured of Owen's speculations regarding the "original design" which was supposed to underlie the head and body segments of vertebrate animals When Cleland became junior demonstrator to John Goodsir in 1857—Sir William Turner was then senior demonstrator– he applied himself chiefly to the morphological problems of the vertebræ and of the skull He published many dissections made on rarer animals, but the work he will be best remembered by is that done on the human skull Unfortunately, in 1857, Goodsir's great gifts were already being sapped by the disorder which carried him off ten years later; it is vain to speculate now as to the course events would have followed if Goodsir had retained his full powers of mind; his disease certainly fanned his tendency towards transcendentalism, and it was this side of his mind which had the strongest influence on his junior demonstrator.

In 1861 Cleland left Edinburgh to demonstrate anatomy under Prof. Allen Thomson of the University of Glasgow, one who was a master of scientific method. In 1863 he was appointed to his first chair, in Queen's College, Galway. His best known research was done while he was there, and was published in the Philosophical Transactions (1870, vol. 160, p. 117), on "An Enquiry into the Variations of the Human Skull, particularly in the Antero-posterior Direction." This inquiry has not received the attention it deserves, for in

it Cleland directed attention to the remarkable changes in shape which the human skull passes through at various stages of growth of the child and at later phases of life. Even in adult years head form is not fixed; significant changes may occur in the later decades of life. Between 1855 and 1906 he published more than fifty separate papers and covered a variety of subjects. He was a poet and published a book of verse, "Scala Naturae" (1887); a volume of essays, "Evolution, Expression, and Sensation" (1881); he was one of the editors of the seventh edition of Quain's "Anatomy" (1867), with his former pupil, now Principal J. Yule Mackay of University College, Dundee, he wrote a text-book on "Anatomy (Human Anatomy, General and Descriptive)," 1896, and a "Directory for the Dissection of the Human Body" (1877). A. K.

Dr A de Watteville

Dr de Watteville, whose death, at the age of seventy-eight, occurred in Switzerland on February 24 last, was a prominent member of the medical profession in London between twenty and thirty years ago. A Swiss by birth, scion of one of the oldest families of Switzerland, he was an Englishman by education, and qualified for the medical profession. He specialised in neurology, and more particularly in electro-therapeutics, which he did much to establish on a scientific basis. His work on "Medical Electricity," which ran through two editions—the second in 1884—established his reputation as the chief authority on the subject in Great Britain. He specially insisted on measurements of current strength as the essential condition of a rational application of electricity, and led to the milliampere being adopted as the electro-therapeutic unit by the International Congress of Electricians.

It was, however, as editor of *Brain* that Dr de Watteville found his chief interest and occupation. In 1883 he became associated as co-editor with the original founders and editors of this important journal—the late Sir J. C. Bucknill, Dr. Hughlings Jackson, Sir J. Crichton-Browne, and Sir David Ferrier—and in 1886 was appointed sole editor, when *Brain* became the official journal of the newly founded Neurological Society. This post he held until 1900. On his resignation the council of the Neurological Society by unanimous resolution paid him the following well-merited tribute:

The Council accepts with great regret Dr. de Watteville's resignation of the Editorship of *Brain*, and desires to take this opportunity of recording the deep debt of gratitude that the Society owes him for the way in which he has conducted the Journal for the past twenty years. The Council feels that parting with Dr de Watteville is an event of great moment to the Society, for he has not only brought *Brain* to a high standard of perfection and secured for it a great European reputation, but even the existence of the Journal at the present time is due to his energetic action at a critical juncture in 1880. Moreover, the Council is mindful that the Society itself took origin on Dr de Watteville's initiative at a meeting held at his house on November 14, 1885.

Soon after resigning the editorship of *Brain*, Dr. de Watteville left London and went to reside in Switzerland, and spent the remainder of his life in quiet study and contemplation among the beautiful surroundings of his native land. Dr de Watteville was a man of wide culture and great force of character, charitable and self-sacrificing almost to a fault, and the outspoken foe of quackery and pretence of every description. D. F.

We regret to announce the following deaths:

Dr. W. F. Hillebrand, chief chemist of the U.S. Bureau of Standards, who was distinguished for his work on rock and mineral analysis, on February 7, aged seventy-one.

Prof. A. von Wassermann, emeritus professor of experimental therapy and immunology in the University of Berlin and director of the Kaiser Wilhelm Institute for Experimental Therapy in Berlin-Dahlem, on March 16, aged fifty-nine.

Current Topics and Events.

Elsewhere in this issue is an article by Prof. Raymond Dart dealing with certain evidence which, on his view, reveals a long history of cultural contact between South Africa and the outside world from an early date. It is scarcely necessary to emphasise the importance of Prof. Dart's views in relation to the "diffusionist" theories which have been put forward by Prof. Elliot Smith and his colleagues. Perhaps the most striking piece of evidence with which Prof. Dart deals is the parallel drawn between the head-dress and clothing of certain figures in the Bushmen paintings of the Kei River Valley and of figures in the art of Babylonia and Western Asia. Bushmen paintings are thought by some, for good reason, to be relatively modern, the evidence of the incrustation of which Prof. Dart speaks is of little value without further information as to its character and rate of deposit. If the identification of the Babylonian cap were accepted, it would suggest the eighth century B.C. as a probable date, but without a strong corroborative evidence the identification is precarious, especially as this type of cap is of extreme rarity in Babylonian art. Prof. Dart is on surer ground when he points to the problem presented by the extensive traces of early mining activity in Rhodesia. It may be that the researches of the Committee of the British Association which is investigating the composition of early bronzes may point to South Africa as one of the possible sources of supply and thus afford some clue to the date of some of these workings. It is, however, beyond question that the discovery by Dr. Randall-MacIver in the ruined structures of Rhodesia of Nankin china which could not be dated at the earliest much before the fourteenth century, is a great stumbling-block in the way of those who seek to prove an early date for the Zimbabwe culture.

With the past two or three weeks reports have reached Great Britain of a new experiment carried

out by Prof Michelson and Dr. Silberstein in the United States, on the principle of the Michelson-Morley experiment, to test the drift of the ether in relation to matter in motion. No authenticated account of the experiment is yet available, but references have been made to it in letters from the United States, and the *Morning Post* of March 2 and 7 published articles stating that evidence of relative motion of ether had been obtained. It is stated that a triangle of three water conduit pipes was used, and that the velocity of light travelling round the triangle was found to be different in two opposite directions Sir Oliver Lodge, in reply to an inquiry as to whether he had received any details of the experiment and the result, has been good enough to favour us with the following comments upon the subject: "In response to your inquiry, and judging solely from the newspaper accounts, the experiment mentioned as having been conducted by Prof Michelson and Dr Silberstein appears to be a repetition of the Fizean moving-water experiment, in which the water is this time kept stationary with respect to the earth, and only shares the earth's rotation. If the rest of the apparatus did not share the earth's rotation, no one would doubt a perfectly calculable positive result. The difficulty and interest arise from the obvious fact that the rest of the apparatus must have shared in the earth's rotation; so that an effect was (presumably) observed which did not involve relative motion of matter. But, assuming all this true, the obvious way out is that 'rotation' has always been regarded as exceptional; and the observation, however interesting and important, need be no more perturbing than Newton's bucket or the shape of the earth"

AN important discovery by the Harvard-Boston Expedition to Egypt, which is working among the Giza pyramids, is announced According to a *communiqué* issued by the Egyptian Ministry of Public Works which appeared in the *Times* of March 10, a tomb has been found of which the burial chamber is at the bottom of a 150 ft. shaft Although no detailed examination had then been possible owing to the unsafe condition of the shaft, a rectangular alabaster coffin was visible with a number of poles, the tops of which were covered with gold foil. Among inscriptions on a plank by the side of the coffin was the cartouche of Seneferu, first king of the Fourth Dynasty, which would suggest that it is the burial-place of a member of his family. The unusual depth of the shaft, however, and the fact that it is filled with concrete and cement instead of rubble as in other tombs in this area, have been taken to support the view that this is the tomb not merely of a personage of importance—a high official or a member of the Royal Family—but possibly of King Seneferu himself, although he is usually supposed to have been buried at Medum, where he built a pyramid. Dr. Reisner, however, who is in the United States, has cabled since the announcement of the discovery that the tomb is that of the Princess Medti-Seneferu. Presumably he has definite evidence to this effect. The floor of the tomb is covered by a quantity of objects, including alabaster bowls, a copper basin or ewer, and remains of heavily gilded chairs If it should appear eventually that this is the tomb of the King himself, it would constitute a discovery of great historical importance, but scarcely of less moment to the archæologist is the evidence which the tomb will afford in regard to the art and technique of the smaller objects mentioned, of which at this period little is known.

THE sixth of Sir Oliver Lodge's series of "talks" on "Ether and Reality," broadcasted from the London station (2LO) of the British Broadcasting Company on Tuesday March 17, dealt with matter as one of the forms of energy. Sir Oliver said that one of the functions of the ether is the constitution of matter itself Atoms are built of electrons and protons, and electrons are evidently composed of ether, because whatever mass they have is represented by the energy of their electric field, though we cannot yet, with any certainty, make a similar statement about a proton We know, however, that both are more massive when moving than when they are at rest Their mass and energy increase together, the extra mass behaving like additional matter, but not like permanent matter When an electron is stopped, the additional matter disappears. it is changed into radiation and travels out as a quantum with the speed of light There is a curious kind of discontinuity in the immediate neighbourhood of a material nucleus: the satellites can occupy certain positions and no others But they can drop from one of these positions to another, and they then emit energy in the form of radiation, which depends on how far they have dropped and where they drop to. The process is a reversible one, and when radiation is absorbed, the electron is jerked up again How far it is jerked up depends on the kind of radiation. The important thing is that matter is turning out to be one of the forms of energy This has been proved for temporary matter, and is probably true for permanent matter also, a conversion of which is believed to account for stellar radiation Whether the process is reciprocal—whether radiation can ever generate not only temporary matter but so-called permanent matter—still remains to be discovered

A SCHOOLBOY once replied to the question "What is an egg?" by stating that an egg is "an oval-shaped article of diet." The Concise Oxford Dictionary says that it is a "spheroidal body produced by female of birds, etc., especially of domestic fowl, containing germ of a new individual" Neither of these definitions can be regarded as entirely satisfactory from the scientific point of view, but the latter has the advantage of grasping to some extent the fundamental point and of restricting the application of the term to bodies of a similar nature A more precise definition is usually given by biologists of the Latin word "ovum," used as a technical term; an ovum, or egg-cell, is a nucleated cell capable of developing (usually after union with a spermatozoon) into a new individual; a conception, of course, that was as unfamiliar to Latin writers as it still is to dealers in eggs. An embryo, on the other hand, is an individual in an

early stage of its development from the ovum. Unfortunately even men of science still use these terms in a very unscientific manner Human embryologists not infrequently apply the term "ovum" to quite advanced embryos, thus counteracting the efforts of those biologists who wish to emphasise the fundamental fact that every typical animal starts life as a single nucleated cell—to which alone the term "ovum" should be applied

IN their interesting and beautifully illustrated paper on "The Early Development of the Cat" (*Quarterly Journal of Microscopical Science*, vol. 68, Part IV), Prof. J P Hill and Dr. Margaret Tribe use the word "egg" in much the same way, but what justification can there be for this usage? It fulfils the requirements neither of popular language nor of scientific terminology. It is perhaps less objectionable than the illegitimate use of the word "ovum," which is evidently intended as a technical term and therefore ought to be used only with scientific precision But in what possible sense of the word are these early embryos of the cat eggs? They are not articles of diet, and they are in no way comparable to the egg of a fowl, but only to something which may, in certain circumstances, be found in the egg of a fowl. We call this something an embryo—why should not the same term be used for the early stages in the development of the cat? It is in no mere carping spirit that we venture to make these criticisms, but with the view of directing attention to the necessity for a more rational system of terminology in embryological writings, and nothing that we have said must be regarded as indicating any want of appreciation of a most careful and accurate piece of work, a notable contribution to embryological science

A TIDE predictor has been presented to the Tidal Institute at Liverpool and has been installed at Bidston Observatory The machine has 10 semi-diurnal components, 6 diurnal, 3 third-diurnal, 4 quarter-diurnal, and 3 sixth-diurnal components, 26 in all, provision has been made for the addition of other components, if desired Long-period components have been omitted, as such constituents are easily allowed for, if of importance Very great care has been given to matters of design and workmanship, and the machine has been constructed in an admirably efficient manner by Messrs Kelvin, Bottomley and Baird, of Glasgow The accuracy of performance of the machine is very great, and it is capable of being used even for research work A noteworthy feature of the machine is the provision of apparatus for recording electrically the time at which the tide reaches a definite height The electrical contact is made by a roller on the edge of a wheel, which is attached by a flexible wire to the pen, and the electrical circuit is completed through a dotting apparatus which registers on a revolving drum. The dots are arranged on a spiral line. This chronograph can be used for registering the exact time of high (or low) water by setting on the machine the desired harmonic constants representing the rate of rise and fall of tide. The donors of the machine are Messrs. Alfred Holt, the Booth, Cunard and Orient S.S Cos, Mr. Harrison Hughes, Mr. C. Livingston, and the Local Committee for the Liverpool meeting (1923) of the British Association.

THE *Welsh Journal of Agriculture*, of which the first number has recently been issued, is intended to fill a definite need by providing a channel whereby farmers and others in the Principality can be kept informed of the progress of agricultural education and research in Wales. The published articles are to be based on scientific investigations, and will convey scientific and technical information set out in plain language to render it of the greatest possible value to the agricultural community. The first number appropriately leads off with an outline of the history of agriculture in Wales, by C. Bryner Jones, followed by an article on the human side of the farming business by A W Ashby. Other articles of a general character, but all having a bearing on agricultural development, are given, dealing with genetics and the stock breeder, modern tendencies in soil research, and with various aspects of research in such fundamental matters as animal breeding, dairying, horticulture, and fruit culture The rest of the volume is occupied by a number of short papers on various Welsh investigations and by an important article by Prof Stapledon on "Seeds Mixtures for Temporary Grass" This outlines the results of investigations carried out in Denmark and Sweden in comparison with observations on similar trials now in progress at Aberystwyth, and is of much value as a contribution to the perennial problem which confronts the farmer who desires to put down leys of long or short duration A useful list of recently published agricultural books is included, together with a section of abstracts, reviews, and bibliographical notes.

SIR E JOHN RUSSELL, Director of the Rothamsted Experimental Station, Harpenden, Herts., has been elected a corresponding member of the Paris Academy of Sciences, in the Section of Rural Economy, in succession to Prof. Winogradsky, who has been elected a foreign associate

THE Summer Time Bill was read a second time in the House of Commons on March 13. By it the dates between which legal or clock time is to be one hour in advance of Greenwich Mean Time are from the Sunday following the first Saturday in April to the Sunday following the first Saturday in October. If the measure is passed, summer time will begin this year on April 5 and end on October 4. The period during which legal time is thus to be advanced has been decided upon in agreement with France and Belgium, and is to be the same every year instead of being determined year by year, as has been the case since summer time was first introduced in 1916.

ON Tuesday next, March 24, at 5.15, Prof. A. S. Eddington will begin a course of two lectures at the Royal Institution on the internal constitution of the stars; on Thursday, March 26, at the same hour, Mr. T. Thorne Baker will deliver the first of two lectures on the chemical and physical effects of light:

(i.) "Reproduction of Light Images by Photography," (ii.) "Transmission of Light Images by Electricity"; and on Saturday, March 28, at 3 o'clock, Prof J. H. Ashworth commences a course of two lectures on the nervous system and some reactions The Friday evening discourse on March 27 will be delivered by Sir Ernest Rutherford on "Studies of Atomic Nuclei," and on April 3 by Sir Daniel Hall on "The Productivity of English Land"

THREE research assistants are required at the Building Research Station of the Department of Scientific and Industrial Research. Candidates must be honours graduates in chemistry or have an equivalent qualification, with some experience in research One post requires a special theoretical knowledge of paints and varnishes, another of physical chemistry, and another of inorganic chemistry, a good knowledge of metallography, and ability to read French and German Applications, upon a special form, must be received by, at latest, March 28 by the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S W.1

AT the annual general meeting of the Ray Society on March 12, the following officers were re-elected: *President*, Prof. W. C M'Intosh, *Treasurer*, Sir Sidney F Harmer, *Secretary*, Dr W T Calman Lord Rothschild was elected a vice-president, and Prof A. E Boycott and Mr R T Gunther were elected new members of council It was announced that the first volume of "British Hydracarina," by Mr C D Soar and Mr W Williamson, would shortly be published, and that the issue for 1925 would be the "Life of Wilhelm Hofmeister," by K v Goebel, translated by Prof. F O Bower The Society published in 1862 a translation of Hofmeister's work on "The Higher Cryptogamia," and it seems fitting that the life of the author should now be included in the same series. The Council has also undertaken to publish a monograph on "British Sea Anemones," by Mr. T. A. Stephenson, which will be illustrated with coloured plates from drawings by the author It is intended that the first volume shall form the issue for 1927.

WE learn from *Science* that it has been decided to establish a National Hall of Fame for Engineers, Inventors, and Industrialists in the proposed National Museum of Engineering and Industry to be erected in Washington. Records of the achievements of the outstanding leaders in invention and engineering, now scattered throughout the country, are to be assembled, and all original models, so far as recoverable, are to be obtained for the museum. In addition to the central museum, it is hoped to form a chain of local museums of industry in the industrial centres of the country. Among those who probably will be represented in marble or in bronze in the Hall of Fame will be Charles P. Steinmetz, Alexander Graham Bell, Thomas A. Edison, Orville and Wilbur Wright, Eli Whitney, Captain John Erikson, Mergenthaler, and Robert Fulton.

THE report of the Department of Agriculture of the Tanganyika Territory for the year ending March 31, 1924, gives an account of attempts to improve and extend crop production in that region of Africa. Among the most important features of these experiments was the introduction of ploughing among native cultivators The sub-district of Shinyanga was selected for the experiment as having certain advantages in a closely settled population and extensive areas of cultivable soil in open country free from the tsetse fly. The attempt was facilitated by the growing interest of the natives in cotton production, while the tribal organisation lent itself readily to a system of cultivation by communities A station for the training of oxen was established, where the natives were instructed in ploughing Twenty-five ploughs were then issued to native villages, with the result that 500 acres of land were put under cotton, and requests have been made for a supply of 320 additional ploughs for use during next cotton season A further development of the work which is even more striking consists in the extension of ploughing into areas at present covered by bush and infested by tsetse fly This not merely increases the area available for cultivation but also causes the recession of the fly-stricken bush, which was advancing into open country and restricting cattle-grazing grounds

THE Botanical Society and Exchange Club of the British Isles issues with its report for 1923 a plate illustrating the little sedge *Carex microglochin* Wahl, the discovery of which at Glen Lyon, Perthshire, by Lady Davy and Miss Gertrude Bacon, is described by Dr. G. Claridge Druce, the secretary of the Club, as the great botanical event of the year In addition to the usual notes upon rare finds during the year, or references to interesting work upon British species and new county records, the report contains several papers of distinct interest to systematists, such as the paper upon British forms of Thymus by K Ronniger, Vienna, notes on British mints by J Fraser, on violets by E S Gregory, upon *Orchis maculata* L and *O Fuchsii* Druce, by G Claridge Druce Descriptive accounts of special areas of vegetation include that upon the vegetation of Beinn Laoigh (Perthshire) by Donald Patton, and of the Culbin Sands by E J A Stewart and Donald Patton The report closes with a very interesting illustrated account of the foundation of the Oxford Botanic Garden and its tercentenary by Dr. Druce No one is better qualified than this writer to evoke in a few brief pages memories of the many botanists officially connected with this historic botanic garden

IN his article on "Early Activities of the Royal Society," in NATURE of January 31, Mr. T E James referred to the election of Pepys and his undertaking in 1674/5 to provide a lecture for the Society. Mr. James was unable to find any record of Pepys having kept the promise or paid the fine in default, and he remarked that there was "no reference to this lapse in the well-known Diary." Mr C. Macnamara writes from Arnprior, Ontario, to point out that the last date in the Diary is May 31, 1669, that is, several years before Pepys made the promise mentioned in the article.

THE efficient equipment of observatories calls for the services of the engineer as well as the scientific-instrument maker and the optician. The firm of Messrs Cooke, Troughton and Simms, Ltd., Buckingham Works, York, are fortunate in having at their command facilities for the production of all the apparatus and equipment required for astronomical observation. Several well-known observatories have been built and equipped by the firm, and this branch of their production is now being further developed. A recently issued catalogue, No 570, contains a full list of astronomical instruments and apparatus manufactured by them, including domes from 10 to 40 feet in diameter, telescopes with objectives up to 20 inches in aperature, a full range of eyepieces, photographic and spectroscopic accessories and position micrometers. Portable equatorial and alt-azimuth stands, semi-portable and fixed equatorial telescope mountings and transit instruments, of various types, are described and illustrated, as well as mechanical and electrical accessories The articles included in the catalogue are all standard apparatus and instruments, for which prices are quoted; but the firm undertakes also the design and construction of instruments for special purposes.

Two important catalogues of second-hand books of science have just been issued by Messrs Wheldon and Wesley, Ltd, 2 Arthur Street, W C.2, viz. No. 15, Zoology, Part 2—Vertebrate Faunas, containing nearly 1500 titles, and No 16, Lepidoptera, with some 262 titles A number of scarce works are offered for sale, and the catalogues should appeal to many readers of NATURE

Our Astronomical Column.

MIRA CETI —There have been three interesting discoveries made concerning this famous variable in recent months The finding of the faint companion, that is responsible for the bright lines seen in the spectrum at *minimum*, has already been reported in this column The next step was the investigation of its heat radiation by the thermocouple by Messrs Nicholson and Pettit at Mt Wilson, this was described by Prof Eddington at the February meeting of the Royal Astronomical Society (see *Observatory* for March, p 58) While the visual magnitude varies from the third to the ninth, a 200-fold range, the "heat magnitude" varies only from 1·5 mag to 3 mag, a 4-fold range This shows that the loss of light is almost wholly in the short wave-lengths

The third discovery, reported in the *Times* of March 12, is that Dr F Pease has successfully applied the 20-ft interferometer on the 100-inch reflector at Mt Wilson to the measurement of the angular diameter of Mira, obtaining the value of 0·06″, which is the largest yet found for any star, though its linear diameter would be about equal to that of Betelgeuse, each being about 250 million miles, assuming that their adopted parallaxes are correct

It is evident that the surface brightness of Mira must be very low, since in spite of its greater angular diameter it is some two magnitudes fainter than Betelgeuse even when at its maximum light It will probably be followed for as long a portion of the light curve as the interferometer method permits, in order to see whether the diameter varies periodically. Such a variation was strongly suspected in the case of Betelgeuse, itself a variable but with a much smaller range

Mira is probably the nearest to us of the long-period variables, and anything found about it may be applicable to the whole class They were formerly thought to be expiring suns, but are now considered to be at an early stage of star-life

A NEW APPLICATION OF THE SPECTROHELIOGRAPH. —Mr Royds, Director of the Kodaikanal Observatory, described at the meeting on March 13 of the Royal Astronomical Society, a new method of using this instrument Instead of placing the second slit wholly on the H_α line of hydrogen, it was made to project on to the light spectrum, the character of the image was then found to be entirely different Instead of measuring the amount of light from glowing hydrogen in different regions, it now measures the varying pressure of the gas by the varying width of the line, and consequent reduction of light where it is broadest and the pressure greatest

Each sunspot is found to be surrounded by a narrow bright ring, outside this there is a large dusky region, showing a good deal of structure. The general mottling of the whole disc is very clearly brought out, and seems to have more regularity than in ordinary pictures The method is quite a hopeful one for bringing out some new points concerning the distribution of gases over the sun's surface

THE SYSTEM OF β-LYRÆ —Prof H. H Turner, at the meeting on March 13 of the Royal Astronomical Society, announced an interesting result which Miss Blagg has obtained She finds that there is a small subsidiary variation of light, the amplitude of which is about 0·1 magnitude, and period 6·595 days, very little in excess of the 6·454 days which is the half period of the main variation It is this approach to synchronism that has prevented the new term from being detected earlier It shows itself not as a separate curve, but as a slow alteration in the amplitude of the principal curve No suggestion was made of the explanation of this new term. As the two stars are supposed to be almost in contact, there would not seem to be room for a third orb in their immediate vicinity.

THE DISTANCE OF THE ANDROMEDA NEBULA —Prof. H N. Russell gives some further details in *Scientific American* for March of Prof. Hubble's investigation of the distance of this nebula by photographing the Cepheid variables in it He mentions the possibility that was alluded to in NATURE of March 7, p 349, that absorption by the nebula might diminish the stars' light and so give too large an apparent distance. But he says that several stars in different parts of the nebula agreed in giving the same distance, thus showing that the absorption effect must be very small, since otherwise it could scarcely be the same for all the stars Prof Russell also notes that stars that are individually visible in the nebula must be a thousand times as luminous as the sun; hence only the extreme giants are separately visible, and the great mass of the stars in it are only seen as a general glow. There is still something of a puzzle about the very rapid diminution of light as we pass away from the centre that was found by Mr. Reynolds's photometric measurements. This seems to indicate a different structure from that in our sidereal system.

Research Items.

PALÆOLITHIC MAN IN CENTRAL EUROPE.—L'Abbé Breuil continues his account of his "voyage paléolithique" in Central Europe in *L'Anthropologie*, t. 34, No. 6. He now deals with finds in the loess of Moravia and Bohemia, which are to be described in two sections, the first, which is the present instalment, covering open-air shelters, and the second the caves Three stations in Moravia are described: Premost, Ondraditz, and Brno (Brünn). As regards the human remains found at Premost, L'Abbé Breuil is of the opinion that the view of Dr. Hrdlička and Dr Matiegka, that Premost man represents a cross between Neanderthal man and the Aurignacian races, cannot be maintained. The prominent supraorbital ridges cannot be regarded as a decisive criterion against the absence of characters such as the remarkable platycephaly, the development and specialised character of the face, of the nose and orbits, and the receding chin of Neanderthal man—characters which are far more significant than the prominence of the supraorbital ridges The same applies to the Brno man. Both must be regarded as Aurignacian, differing from Aurignacian man in Western Europe, it is true, but also exemplifying the highly diversified character of the Cro-Magnon race, which was probably already a mixed race when it penetrated Europe.

ANTHROPOLOGY OF THE CHINESE.—Mr W W. Cadbury, of the Canton Christian College, contributes to the *Philippine Journal of Science* for December a study of the height, weight, and chest measurements of Mongolian peoples, with special reference to the Southern Chinese He has made a valuable digest of the literature dealing with these points and has added to it the results of his own observations on the students of the Canton Christian College The general conclusions at which he arrives are that the Chinese people average 165 cm. in height, the people south of the Yangtze being generally taller than those to the north of the river Cantonese students of 20 years or more average 163·6 cm The average weight for the Chinese is 56·9 kgm. in the north, 52·6 kgm in the south, Cantonese students 51·9 kgm. The weight-for-height index varies from 313 in the south to 384 in soldiers of the north. Cantonese students average 317. Chest circumference is relatively small, varying from 77 4 to 86·9 cm Cantonese students have an average circumference during rest of 78·9 cm. with a play of about 6 cm

CANCER AND GOITRE.—In a recent number of *Biometrika* (vol. 16, 1924, p. 364), Dr. Percy Stocks concludes, from a statistical examination of the data of several countries, that there is a distinct positive correlation between the rate of mortality from cancer of the stomach and œsophagus and indices of the prevalence of goitre. An analysis of post-mortem records also leads to the conclusion that enlargements and other anomalies of the thyroid, the anomalies being usually of the type associated with depressed functioning, are more frequent in cases of cancer than in other cases. On the other hand, there is some evidence of a negative correlation between the incidence of cancer and of Graves' disease Dr. Stocks thinks that these findings "seem to indicate that defective functioning of the thyroid gland is favourable to the incidence of cancer of the stomach, and possibly of other organs also."

SOUND PRODUCTION BY INSECTS.—An interesting critical paper on this subject by Mr. Frank E. Lutz is to be found in the Bulletin of the American Museum of Natural History, vol. 50, 1924, pp 333-372, and the conclusions arrived at by this observer may be briefly mentioned He remarks that, leaving out of account the Orthoptera and the cicadas, there are few or none of the sound-making insects that have well-authenticated organs of hearing, or the sound-producing organs of which may not quite conceivably produce the sounds by pure accident and without any purpose or profit. Until we have proof that insects in general purposely make sounds, or that they profit by sounds which they make without intention, there is nothing in our present knowledge of the biology of insects that furnishes good ground for believing that the few cases in which we hear insect-sounds are really exceptions to a rule that insects do not communicate by that means. In the cases of Orthoptera and cicadas, the presence of extreme specialisations, wonderfully efficient in producing sound and apparently not used for any other purpose, gives us a reason for thinking that there is a purpose The presence of what seems to be a definite ear in the stridulating Orthoptera is an additional reason However, when we see that the termites, which are not known to stridulate, have the same sort of an ear as crickets and long-horned grasshoppers, and that the cicadas, which produce a loud (to us) sound, probably have no ear (unless it be connected in a deafening way with the sound-producing structure), this latter reason loses some of its force If these structures have not arisen for the purpose of making sounds, why have they arisen, and how? There is at present no certain answer to this question. In a former paper (Lutz, Annals N.Y. Academy of Sciences, 39, pp 181-282) an attempt was made to show that complicated and definite structures, including details of wing-venation, had arisen by mutation or through the action of developmental factors without any "purpose" or favouring action of natural selection The author does not say that this is true of the cricket's wing and the cicada's drum, but he does not deny the possibility.

CHROMOSOMES OF *PARIS QUADRIFOLIA*.—Mr Bolles Lee contributes another paper (*Quart Journ Micro Sci*, vol. 69, part 1) on the structure and division of chromosomes In a study of *Paris quadrifolia*, he finds that the chromosomes contain a spiral perlaxial filament and are surrounded by a sheath Various observers have described such a spiral, others have interpreted it as a row of alveoli The small sizes of these structures renders their interpretation one of great difficulty The most surprising conclusion drawn is that the chromosomes always divide transversely in the telophase of mitosis, and never longitudinally at all We can only say that much more convincing evidence would be required before such a view could be regarded as at all probable Practically all of these results have been controverted by Martens (*C.R Paris Acad. Sci.* t 179, p 1280) in a preliminary paper in which it is also claimed that a reticulum of delicate threads can be demonstrated in the living "resting" nucleus and is therefore not created by fixation methods

SOME NEW GREGARINES.—B L. Bhatia and S Setna (*Parasitology*, vol 16, p. 279, 1924) record the occurrence of a cephaline gregarine, probably a species of Leidyana, in the alimentary canal of a carpenter bee, *Xylocopa æstuans*—the first gregarine to be described from a hymenopteran host The parasite occurs in large numbers throughout the length of the alimentary canal in every carpenter bee examined, but although the investigation extended

over several months, neither cysts nor spores were met with. The authors suggest that these stages probably occur within the larvæ of Xylocopa. They also record the occurrence of a species of Leidyana in the parenchyma of the polyclad Leptoplana.

COPEPODA OF THE CHILKA LAKE.—Major R. B. Seymour Sewell records (Mem. Ind Mus., vol. 5, pp. 771-851, 16 plates, 1924) the results of his examination of the copepod Crustacea of the Chilka Lake. Of the fifty-seven species present in the collection twelve are regarded as new, and five new varieties are also described. The author gives an account of the changes in the copepod fauna correlated with the varying conditions of the water, *e.g.* the influx of sea-water during the winter months causes a disappearance of the purely fresh-water species which had been carried into the lake during the monsoon. He remarks upon the number of species, hitherto regarded as being typical inhabitants of north temperate or even arctic seas, present in tropical waters. The breeding seasons of many of the species are noted.

HYDRA CHIMÆRAS.—Mr. V. Issayer describes an extended series of experiments (*Journ. Genetics*, vol. 14, No. 3) in producing animal chimæras by grafting together in various ways two species of Hydra, a stalked form of brown colour (*Pelmatohydra oligactis*) and a red variety of *Hydra vulgaris* found near Leningrad the cells of which contain carotinoid and lycopinoid pigments. The former species also has longer tentacles. By pinning together two specimens which had been opened out flat, by inserting an individual of one species into the cavity of another, and by other methods, chimæras were obtained the components of which could be followed by their colour. Mosaics were also obtained by cutting up Hydras into fine pieces and moulding the fragments together. Parts of some chimæras were intermediate in character and were called cytomictical. (It may be pointed out that the term cytomyxis is already in use in cytology in another sense.) Such individuals frequently reverted in buds to *oligactis* but never to *vulgaris*. The bearing of these results on problems of individuality, divisibility, regulation, somatic mutation, and other topics is discussed. A cytological study of these forms is being made which will throw more light on their nature.

SOUTH AMERICAN FUNGI.—Under the title "Fungi Paraguayenses," Carlos Spegazzini describes in the Anales del Museo Nacional de Historia Natural de Buenos Aires, vol. 31, some 267 species and forms of fungi collected by him during a visit to Asuncion in 1920. Many new species are described and figured, spore sizes and figure as well as other microscopic data being supplied.

POISONOUS PLANTS AND LIVE-STOCK.—In the *Kew Bulletin* (No. 1, 1925), J. Burtt Davy has an interesting note underlining the value of scientific investigation of the causes of losses to live-stock as the result of local peculiarities in the quality of the grazing grounds. He uses as a text the important reports upon "Gauwziekte Veld," by Sir Arnold Theiler and Dr. Pole Evans, which have recently been published by the Department of Agriculture, South Africa. The nature of the injury to stock thus produced may be estimated by the fact that one farmer lost 1047 sheep (59 per cent. of his flock) after grazing them for less than twenty-four hours on gauwziekte veld. After prolonged inquiries lasting over ten years and feeding tests with 98 species of plants, these investigators definitely proved that the cause of the losses of stock was *Vangueria pygmæa* (Rubiaceæ). This plant appears to contain a toxic principle, acting directly on the heart, though the toxin has not yet been isolated. Other cases of toxic species in grazing grounds are referred to by the author, who is thus able to make out a strong case for the work of a Government Department of Agriculture by which alone long and extensive investigations, involving the co-ordination of the work of specialists in different fields, can be both promoted and maintained until success is reached.

SYMBIOSIS OF SEEDS AND BACTERIA.—Gilbert J. Fowler and Miss R. K. Christie raise this question on very general lines in their paper in the Journal of the Indian Institute of Science, vol. 7, part xiii. They say that every seed they have examined so far has proved to be associated with specific bacteria either within the seed (poppy), within the husk (rice) attached to the seed by the mucilage coat (*Cassia tora*), or on the testa (indigo-seed). These bacteria are not essential to the germination, but do appear to be helpful in the growth of the seedling. Little difficulty appears to be raised by the authors' conclusion that these bacteria can break down protein reserves, but it is not clear how this property could be utilised by the germinating seedling. An interesting point is raised by the suggestion that the growth of these bacteria is associated with the specific seed extractive, apparently of basic or glucosidic nature, and removable by water or other suitable solvent, which every seed examined appeared to contain. This extractive did not prove on examination to be invariably antiseptic, but it is suggested that, on dilution during germination, it may stimulate the growth of the bacteria associated with the seed whilst holding them in check so long as it is concentrated, as in the resting seed.

CLIMATIC CONDITIONS FOR COTTON GROWING.—Mr. E. E. Canney has carried out a useful piece of work in analysing the climatic conditions required for the growth of cotton without irrigation (Journal of the Textile Institute, vol. 15, p. 1533). He finds that three conditions are essential: freedom from frost during the growing season, adequate but not excessive rainfall, and abundant sunshine. The cloudy, humid climate of large areas of the tropics is fatal to the economic production of cotton of good quality. The mean annual temperature should be above 60° F., the rainfall between 20 and 60 inches per annum, and the mean cloudiness less than five-tenths. On this basis he has prepared maps showing the areas where climatic conditions are favourable for cotton growing, and he finds that there are large parts of the British Empire, awaiting development, with suitable climates for growing as much cotton as is likely to be required for a long time. In the text, and still more strongly in an accompanying letter, Mr. Canney points out the urgent need for trustworthy meteorological observations from many more stations than at present exist in tropical regions. The lack of information as to climate retards development, and may lead to expensive failures owing to attempts to grow crops in regions which are climatically unsuitable.

ATOMIC WEIGHT OF BROMINE.—The January number of the Journal of the Chemical Society contains a paper by H. V. A. Briscoe and P. L. Robinson on the atomic weight of bromine. Ammonium bromide was subjected to 2700 fractional crystallisations from water, the object being to test Richards and Hall's conclusion that isotopes are inseparable by fractional crystallisation. No evidence of separation

was obtained. From the ratio Ag/AgBr, the atomic weight of bromine was found to be 79·914 ± 0·01.

CHLOROPHYLL SPECTRA.—Jan Wlodek has an ingenious suggestion to account for the differences observed between the spectra of chlorophyll in the living leaf and in various solvents. By combining the absorption spectra given by Willstätter and Stoll for chlorophylls *a* and *b*, he obtains a spectrum with absorption bands very closely coinciding with those of the living leaf, far more so than does the absorption spectrum of the alcoholic solution of the mixed pigments. He suggests therefore that in the living leaf the two chlorophylls are present in separate solvents, and that the changes in the absorption spectrum of the leaf under insolation are due either to the proportion of the two pigments changing, a fact that Willstätter and Stoll failed to establish by their classical analyses of the pigments, or that new spectra are developed as the result of temporary combination with carbon dioxide The paper is published in English in the Bulletin de l'Académie Polonaise des Sciences et des Lettres, Séries B, Science Naturelles pp 407-423, 1924, as a contribution from the Jagellonian University of Cracow

ABSORPTION OF RADIATION BY THE EMITTING ATOM.—In the *C.R. Acad. Sci. Paris* of January 19 M. de Broglie and J Thibaut describe measurements of the intensities of the corpuscular lines, due to the conversion of the *K* radiation of tungsten (doublet α) in an element, and of the *K* fluorescence lines of the element itself. The relative intensity of the second, with respect to the first, increases regularly with the atomic number for copper, silver, iodine, and barium. Bragg's law, combined with that of Moseley, would indicate a variation in the opposite direction In the case of radioactive transformations giving β- and γ-rays simultaneously, the β-ray spectrum being due to a photoelectric action of the γ-rays on the electronic shells of the disintegrating atoms, it is found that when the γ-radiation is converted into secondary photoelectrons in an isotope of the disintegrating substance, producing an identical β-spectrum, the intensities of the lines are much less than in the original spectrum of the radioactive substance. Using mesothorium and lead, the ratio of the intensities was found to be very roughly 1 · 10, indicating a much more intense absorption of mesothorium γ-rays in mesothorium than in lead Ellis has come to a somewhat similar conclusion on this subject, though he considers that in a γ-radiator the γ-rays are absorbed most strongly in the actual atom from which they are emitted, a point to which the authors have not directly given attention in their paper.

THERMOPILES IN THE LARGE SCALE MANUFACTURE OF GASES.—In the manufacture of hydrogen by the electrolytic process, it is very important to know at every stage the percentage of oxygen in the gas, and highly desirable to have an arrangement for sounding an alarm signal when the proportion of this impurity becomes too large. Dr. P. Gmelin, in the F. Paschen *Festschrift* number (January) of the *Annalen der Physik*, describes apparatus in which a small quantity of the gas is passed constantly through pressure regulators, half of the stream being sent through a tube of hard glass containing eight alternate thermal junctions of copper and constantan, and half through a similar tube, parallel to the first, which contains the remaining junctions. The two tubes are surrounded by an electric furnace, and in one of them pure platinum is deposited in the neighbourhood of the thermal junctions, to act as a catalyser for the combustion $O_2 + 2H_2 = 2H_2O$, the heat of the reaction being given up to the junctions. When no oxygen is present the registering millivoltmeter, to which the thermopile is connected, is not affected, and when the amount of this gas reaches 2 per cent. the deflexion is sufficient to make an electric contact and ring an alarm bell. It is arranged that this bell shall also ring when the current through the electric furnace is too low and when the gas stream is interrupted. The apparatus can be adapted to show the presence of 0 1 to 2 per cent of oxygen in nitrogen manufactured by the Linde process. Enough hydrogen is added to the test stream to combine with the oxygen and leave a small excess. Instead of the single pair of tubes described, as many as twenty-four pairs have been employed, to register from 0 01 to 0 5 per cent. of oxygen in mixtures of nitrogen and hydrogen.

THE PHYSICS OF SPRAY FLUIDS.—Rowland Marcus Woodman has two further papers upon this subject in the *Journal of Pomology*, vol 4, No. 2, January 1925. In the first paper is studied the influence of various substances in maintaining a suspension of lead arsenate, that is, in preventing its sedimentation, and it is pointed out that this is by no means the same property as that of lowering the surface tension of the liquid air surface so that the spray fluid readily wets the surface of the plants upon which it is discharged As the results of experiment, gelatine and calcium caseinate were found the most effective substances in promoting both these desirable ends, by fine grinding lead arsenate could be got into permanent suspension in water alone, but calcium caseinate, gelatine, or some other substance would still be necessary, in this case, to promote spreading In the second paper the advantages of the method of intermittent shaking for the preparation of emulsions of oil in water are studied and elucidated Gelatine and potash soaps prove to be much better emulsifiers than sodium soaps.

A NOVEL T-SQUARE.—A new T-square and drawing-board made by Axene Ltd, Maxwell House, Arundel Street, W.C, has been brought to our notice. The object of the invention is to "free the hands of" the draughtsman by providing a T-square which will retain its position on the board without any complication of cords or pulleys This is accomplished by the use of a magnet as the stock of the square, running on a steel strip in the edge of the board. The principle is not new, and previous inventions on these lines have not come into general use. The distinction of this square lies in the utilisation of the new magnetic cobalt alloy said to retain its magnetism almost indefinitely, and the whole of the stock is composed of this alloy. An examination of one of these boards suggests that, provided the length of the stock be proportioned to the length of the T in a ratio not less than found in ordinary squares, the T-square retains its position unaided, and assuming the retention of its magnetic properties, should be of considerable value to draughtsmen. These T-squares can be made with movable heads, but the leverage on the fixing screw on a long square is so great that a fixed head is usually preferred, at least for work which is mostly rectangular, and we did not observe any notable improvement in this respect in the square under discussion. Another useful feature of "The Axene" is the bevelling of the under side of the back edge of the square, enabling it to slide over drawing-pins. The drawing-board can be made with a steel strip on the bottom as well as on the left-hand edge, enabling the T-square to be used vertically and set squares to be dispensed with for work in which this position of the T-square is more convenient.

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Technology.

B T Batsford, Ltd —The Elements of Design and Form in Classic Architecture, A Stratton , Architectural Practice and Procedure, H H Turner , Lessons in Carpentry and Joinery a Series of Practical Plates by G Ellis ; Small Houses a Series of Designs, G. Murtagh , The Small House and How to Build it, W. D Brinckloe , Small Chateaux and Churches in France, W. Arnold , Outside the House Beautiful a Series of Garden Illustrations, Henrietta C Peabody , The Architecture of John Russell Pope , Spanish Details · Drawings, Photographs and Text, W L Bottomly , Spanish Provincial Architecture, A. Byne and Mildred Stapley ; Practical Structural Design, E McCullough , Stair Builders' Guide, M Williams , Hicks' Builders' Guide, I P Hicks and J C. Duncan ; Steel Square Pocket Book, D L Stoddard , Furniture for the Craftsman, P D Otter ; Jobbing Work for the Carpenter, Builder and Handy Man, E H. Crussell , Chinese Art a General Review by a number of well-known Authorities, with an Introduction by Roger Fry and many plates in colour and from photographs , Historic Costume a Chronicle of Fashion in Western Europe, 1500 to 1800, F. M. Kelly and R. Schwabe ; The Elements of Design and Form in Classic Architecture, A. Stratton , French Provincial Architecture, P. L. Goodwin and H O Milliken , Popular Weaving and Embroidery in Spain, Mildred Stapley , Expression in the Human Figure : a Series of Photographic Studies by B. Park, with an Introduction by G. M. Ellwood · Indian and Persian Textiles : collected by the great printer Oberkampf in the XVIIIth Century and republished in colour *Ernest Benn, Ltd* —" Gas World " Analyses of Municipal Gas Accounts, 1924, containing detailed analyses of over fifty balance sheets ; The Industrial Applications of Coal Tar Products, H. M. Bunbury and A. Davidson ; Practical Polishing and Staining, A. W Parkhouse, new edition. *Chapman and Hall, Ltd.*—The Technology of Wood Distillation : with special reference to the Methods of obtaining the Intermediate and Finished Products from the Primary Distillate, M. Klar, translated by Dr. A. Rule. *J. and A. Churchill* — A Dictionary of Perfumery, E. J. Parry, 2 vols. *Crosby Lockwood and Son.*—The Modern Soap and Detergent Industry, including Glycerol Manufacture, Dr G. Martin, 3 vols. Vol. 3. The Manufacture, Properties and Uses of Glycerol and Glycerol Substitutes. *Oxford University Press* —Technical Drawing, G. E. Draycott ; Construction and Recognition of Textile Fabrics, A Mason , Elementary Building Science, A Everett. *Scott, Greenwood and Son.* —Colours and Varnishes, C. Coffignier, translated ; Handbook of Technical and Art Schools and Colleges of the United Kingdom *H. F. and G. Witherby.* — House Heating, Dr. Margaret Fishenden.

World Wheat Production.

DURING the past ten years it has been realised that all the countries in the world have a common bond in the international trade in wheat. Various adjustments in relationships have perforce been necessary, but the six years which have elapsed since the War have given wheat-growing countries time to stabilise their positions and in some degree to accommodate themselves, on one hand, to the cessation of export from Russia, and, on the other hand, to the discontinuance of the artificially enhanced production prevalent during the War years. For this reason the agricultural statistics for 1923 [1] published by the International Institute of Agriculture at Rome, with their comparisons with pre-War years, are of special interest, since they do at this stage indicate the trend which agriculture in general and wheat production in particular is taking throughout the world.

The situation as revealed by the year-book is, on the whole, reassuring Except in Europe, both area and production in wheat show an increase over the corresponding figures for the period 1909–1913. In North America the increases in area and production are approximately 40 per cent. The year 1923 was admittedly a favourable one for wheat growing, but an examination of the annual returns shows that this increase is not an isolated instance. Europe is still 7·3 per cent below its pre-War average in production of wheat, and 9·5 per cent below its average area in that crop over the same period ; but the area has increased steadily since 1920, and the production, notwithstanding fluctuations, has never fallen lower than it was then.

Russia is omitted from these returns, but the decrease in wheat production in that country during 1922, when famine conditions were at their worst, is now authoritatively stated as fifty-five and a half million quarters, or 65 per cent. of the pre-War average. In 1923 Russia had a small export trade. It will be remembered that, before the War, Russia was one of the chief sources of the world's wheat supply.

A good deal of attention has recently been directed towards the wheat production and crop balance-sheets of Canada and the United States. No appreciable decrease in area under cultivation in either country is

[1] International Year-book of Agricultural Statistics for 1923. Rome : Imprimerie de l'Institut International d'Agriculture, pp. xxv + 472.

recorded in the data published, but wheat production in both is less in 1923 than in 1922. Almost the whole of this loss can be apportioned to the United States, where increases in the more important crops of cotton and maize more than counterbalance it. Four million acres went out of wheat in 1923 and 5·4 million were added to the maize and cotton crops Further, the excess of exports over imports of wheat has fallen from 32 million quarters in 1921 to 9·6 millions in 1923. Taken together, these figures would seem to afford a striking confirmation of the forecast made by the Bureau of Agricultural Economics in the U S Department of Agriculture Year-book for 1921. In a paper on "Wheat Production and Marketing," O. E. Baker says, "Wheat production, however, has been increasing less rapidly than population in this country, and it is very probable that this will continue to be true, at least until we reach the point where we consume practically all we produce." Such a state of affairs is obviously of very serious import.

The International Year-book has grown during its brief career, and this issue gives many more details than its predecessors. It is to be regretted that in so doing it has been thought necessary to discontinue some of the summary tables. That relating to the percentage of each crop, based on total area under cultivation in each country, is a noticeable omission. The book contains sections dealing with crops, live-stock, trade returns, prices, freight charges, fertiliser consumption, and rates of exchange, and will repay perusal not only by the agriculturist and economist but also by the interested layman

Critical Ionisation Potentials.

THE publications in the Bulletin of the National Research Council of the Washington Academy of Sciences have included many numbers which are excellent reports on the state of knowledge at the time of publication in special branches of modern science. The monograph under review [1] is stated to be the first of a series which, when complete, will form the report of the National Research Council Committee on Ionization Potentials and Related Subjects. The monograph is in two parts, the first of which, by Prof. K. T. Compton of Princeton University, deals with the methods by which critical potentials for the excitation and ionisation of atoms and molecules by electron impacts have been measured. The author gives a very clear account of the principles of the various experimental methods of determining the critical potentials of gases and metallic vapours, and of investigating their significance. There is also a brief section on the critical potentials for the production of soft X-rays from solids. The text is well illustrated by diagrams of apparatus and experimental curves, which will be particularly appreciated by the general reader.

The second part of the work deals with the interpretation to be placed on the critical potentials which have been measured, that is to say, it is a discussion of the nature of the particular disturbance produced within the atom or molecule at each critical stage. It is written in a clear and concise manner by Dr. F. L. Mohler, of the United States Bureau of Standards. The relation between lower critical potentials and arc spectra is first given. Multiple excitation phenomena and the higher critical potentials of gases are then dealt with, and the interpretation of the latter class of data is further considered in connexion with the results for soft X-rays from solids. A final section deals with the results which have been obtained from experiments on polyatomic gases, and their relation to thermochemical data. The whole is illustrated by clearly drawn energy diagrams and Moseley curves.

The bibliography which is appended to the monograph is a very comprehensive one and will be of value to research workers in this field. Altogether the book forms the most complete summarised account we have seen of the work which has been done in the important branch of modern physics with which it deals, and the authors are to be congratulated on their excellent production.

[1] "Critical Potentials," by K. T. Compton and F. L. Mohler, Bulletin of the National Research Council, Vol. 9, Part 1, No. 48. Pp. 135. (Washington, D.C.: National Academy of Sciences, 1924.) 1.60 dollars.

University and Educational Intelligence

BRISTOL.—A lecturer in physiology will shortly be appointed, with duties to begin on October 1. Particulars of the post may be obtained from the registrar. The latest date for the receipt of applications for the lectureship is April 20.

CAMBRIDGE.—The Adams Prize for an essay on "The Physical State of Matter at High Temperature" has been awarded to Mr R. H Fowler, Trinity College. A Smith's Prize has been awarded to T G Room, St. John's College, for an essay on "Varieties generated by Collinear Stars in Hyperspace" F. C Phillips, Corpus Christi College, has been elected to the Amy Mary Preston Read Scholarship.

The subject for the Adams Prize for 1925–6 is "The Constitution of the Interior of the Earth and the Propagation of Waves through the Interior and over the Surface of the Earth" The adjudicators say that "the facts as to the propagation of earthquake waves may now be considered fairly well established, and a discussion is asked as to the deductions which can properly be drawn as to the constitution of the interior of the earth. Such questions may suitably be treated as the reflection, refraction and dissipation of waves at surfaces of discontinuity, if any, inside the earth, also the interior arrangements which would best account for the ordinary P, S seismological tables. A discussion might also be given as to how far the various suspected periodicities of earthquake phenomena, if real, must be attributed to a periodicity of external agents, and how far, if at all, they represent periodicities of free vibrations of the earth itself." The Prize, which is of the value of 240*l*., is open to competition of all persons who have at any time been admitted to a degree in the University

Grants have been made from the Worts Fund to Mr. T R. Parsons, Sidney Sussex College, towards expenses incurred in studying with Prof Orbeli of Leningrad the operative procedure used in research by the physiologists of the Pavlov School, and to Mr. K. de B. Codrington, Corpus Christi College, towards the expenses of a visit to India for the purpose of carrying out archæological research at Elura, Hyderabad State, and at Badami, Bombay Presidency, and of making moulds of the sculpture

It is proposed to erect the new Pathological Laboratory on the Downing site near the Biochemical Laboratory and the Molteno Institute of Parasitology.

Emmanuel College is offering to a research student commencing residence at the University in October 1925, a studentship of the annual value of 150*l*., which will be tenable for two years. Applications must reach the Master of Emmanuel (The Master's Lodge, Emmanuel College, Cambridge, England) not later than July 31. The award will be made on the evidence submitted by the candidates, which must include a brief statement of the proposed course of research and evidence of general ability and of special fitness for the proposed course of research.

GLASGOW.—The late Dr John Hall, a graduate of Glasgow, of St John's Wood, London, who died in 1909, left the reversion of one-half of his estate to the University, for the foundation of tutorial fellowships in medicine, surgery, and obstetrics, for the better equipment of the practical classes in these subjects, etc. Through the death of his sister, who has added half her own estate to that of her brother, the large endowment has now accrued, and may amount to some 50,000*l.* when the estates are realised. The benefaction will be of great use to the University's large school of medicine, which now exceeds in numbers and in clinical resources any other in the kingdom.

Dr J. S. Haldane, fellow of New College, Oxford, has been appointed Gifford Lecturer at Glasgow for the years 1926, 1927.

MELBOURNE.—Applications are invited for the professorship of agriculture and the post of research physicist. Conditions of the appointments may be obtained from the Agent-General for Victoria, Victoria House, Melbourne Place, Strand, W.C.2. The latest date for the receipt of applications is May 31.

APPLICATIONS are invited, until April 18, for the professorship of philosophy at the University College of Swansea. Particulars of the post may be obtained from the College Registrar, Singleton Park, Swansea.

AN election to Beit fellowships for scientific research at the Imperial College of Science and Technology, South Kensington, will take place in July next. Applications must be received on or before April 18. Forms of application and all information can be had by letter addressed to the Rector of the College.

VISCOUNT BURNHAM will deliver an address on "Technical Education as it affects Employers of Labour" on Friday, March 27, at 8 P.M., at the Battersea Polytechnic, London, S.W.11. The Governing Body of the Polytechnic has extended an invitation to the London County Council Joint Standing Conference of Evening Institutes in the district to hold at the Polytechnic an Exhibition of Work done by students on Friday evening and Saturday afternoon and evening, March 27 and 28, while the laboratories, workshops, kitchens and demonstration rooms of the Polytechnic will also be open for inspection.

SOME of the inner working of a preparatory school on modern lines is shown in a pamphlet entitled "St. Piran's Year Book for 1924," recently received. Few people realise how fundamentally wrong is the system of so-called education in a great many preparatory schools where the only object seems to be to cram in a knowledge of a few subjects—principally Latin and Greek—to meet the requirements of the Common Entrance Examination. How this can be expected to encourage latent ability, even for languages, much less to reveal a boy's true bent, passes comprehension. Every schoolmaster admits what Mr. Secretary Cecil said to Roger Ascham, very wisely and most truly, when the great plague was at London in 1563: "Many young wits be driven to hate learning before they know what learning is." The headmaster of St. Piran's, Maidenhead, has shown in a very practical way how scholarships can be won and examinations passed without serious detriment to education in the true sense of the word. Natural science, for example, is taught to the boys at St. Piran's although the Common Entrance Examination does not require it. An engineering shop, various societies—literary, natural history, wireless, photographic, gardening—and lectures on subjects of current interest provide stimuli calculated to reveal latent ability. This is, or should be, the true aim of all education. To the impartial mind it appears that this out-of-date Common Entrance Examination condemns the boys in most preparatory schools to do merely school work in school, while the education, if any, they may have the luck to acquire is most likely to be picked up in out-of-school hours.

THE Battersea Polytechnic's report for 1923–24 shows 2735 as the total number of students, 447 being full-time and 2288 evening and other part-time students. The full-time courses were chiefly in the Training College of Domestic Science, and in engineering. Of the entries for part-time work about a third were for mechanical engineering and building and electrical engineering, a third for physics, chemistry, and mathematics, and the rest for women's subjects, music, hygiene and physiology, matriculation classes, physical training, and art. The figures are large, but a comparison with the figures for previous years is disquieting. The Principal points out that there is a steady decrease in numbers, and says it is largely due to the increased fee for out-county students (to cover the difference between the ordinary fee and the cost to the L.C.C. of the student's education) and the cessation of work under the Government scheme for the higher education of ex-service students. The decrease in the number of full-time students is fully accounted for by these reasons, but there remains a large decrease, nearly 600, in the number of evening students (comparing 1919–20 with 1923–24), attributable in part it may be supposed to the slump in the engineering trades. An interesting development in the Department of Hygiene and Public Health is the institution of a course in practical home dietetics (gas-ring or oil-stove cooking) for bachelor men and women. The enrolments in this department show a substantial increase.

THE international interchange of university students and university teachers has attracted much notice since the War. Many post-War organisations—the League of Nations' Committee on Intellectual Co-operation, the International Confederation of Students and its affiliated national unions, and many others, as well as older associations, such as the League of the Empire and Victoria League, make the fostering of such interchange one of their chief objects. The Universities Bureau of the British Empire has an Interchange Committee, consisting mainly of the Interchange Correspondents of the Bureau in the home universities, and has for several years printed and circulated annually a list of students from other countries in the universities and university colleges of Great Britain and Ireland. To the list for the current academic year is appended a list of university professors and lecturers of these universities who in 1923–24 visited universities in other countries and vice versa. No official sources of information exist regarding the visits of university teachers, since many of them are arranged without the official cognisance of the registrars of the home universities: indeed, the list is so scanty as to suggest that the visits of these "merchants of light," as they have been called, resemble, in being few and far between, if in no other respect, the visits of angels. Nevertheless the list is interesting as a pioneer attempt which should be repeated with more success. When one considers the expenditure incurred in the world of finance and commerce in recording and publishing statistics of imports and exports of material commodities, one wonders that the learned world has not long ago insisted on receiving systematic intelligence of the interchange of savants.

Early Science at Oxford.

March 23, 1685–6. An abstract of Mr. Bent's travailes in France, was communicated by Mr. Welsteed, and read —Mr. Walker delivered in papers on an empiricall way of curing ye Cramp by a piece of ye root of fflag, and on Second-sighted men in Scotland, concerning whom Dr. Garden was desired to give his opinion.

March 24, 1684–5. Mr. Dalgarno advocated the bringing of a Philosophicall Language into practice He also presented a compendium of a book, not long since printed by him, entitled *Didascolcophus*, which among other things undertakes to prove, that the Eye & Hand are more useful organs of knowledge, than the Tongue and Ear. This gave occasion to some discourse concerning the Vigour and improvement of some one Sense, upon the Defect, or non-employment of one or more of the others, upon which subject Mr President was pleased to informe us, that Mr. Whaly (the deaf gentleman, whom he taught to speak) could, when within doors, distinguish a coach from a cart in ye street by the motion, it made, when those, who were in company with him, could not discern whether it were the one, or the other, by the noise, it made.

March 26, 1684–5. Ye Rt. Honorable the Lord Visct Weymouth, in answer to Dr. Plot's queries, concerning ye splitting of Trees by ye late Frost, wrote that great damages in this kind have befallen ye timber trees in most of ye northward midland counteys, but very little or none in ye western counteys of England

Ordered that ye thankes of this Society should be returned to Mr. Molineux of Dublin for his ingenious discourse concerning ye Petrifications of Loughneagh. in which it having been affirmed, that these petrifications are sometimes found in ye earth near ye Lough, it was queried, whether ye earth, in which these petrifications are sometimes found, may be supposed to have been thrown up from ye Lough? It was then proposed by Dr Beeston, that ye Petrifying Springs in, and near Oxon, should be strictly examin'd, particularly as to their chymicall principles, and that enquiry should be made into ye severall steps, and progress, of their respective petrifications —Mr. Packer, Physitian of Reading, gave an account of some observations he made lately in ye dissection of a Bear; particularly that there was no *Cæcum*, & that ye æsophagus consisted of so narrow a channell, and ye stomac, and entrails, are so well fixed in ye abdomen, that it was altogether impossible, they could at any time fall into ye mouth, as it was formerly supposed it might be in some postures of this animall It was ordered, that thankes should be returned to Mr. Packer, and that he be desired to continue a correspondence with us.

March 27, 1688. Dr. Plot gave the Society the sight of a Paper written for his Majesty's use, about felling Timber in Staffordshire, where they bark their trees in the spring and cutt them down in winter, which hardens the timber, soe that the outside is as hard as the heart of the tree. For felling wood in winter he brings the authority of the antients, Pliny, Theophrastus, Cato, &c. for the advantage of it. He shewed how the barking of it in the summer farthers the hardening by closing the pores in the evaporation of the juice by the heat of the sun. There is no objection against it but that t'will be more troublesome to fell the Timber so hardened, and to bark it standing, and so dearer, but the goodness will sufficiently answer the price.

Societies and Academies.

LONDON.

Royal Society, March 12 —Sir Charles **Sherrington**: Remarks on some aspects of reflex inhibition. Attempt is made to schematise in a diagram certain features of the interaction of central inhibition and excitation. Assumption is made of an inhibitory agent liberated centrally which neutralises chemically an excitatory agent when this latter is present, but the liberation of which is not dependent on pre-existence of the excitatory agent Tetanic inhibition is dealt with as due to iterate production of the inhibitory agent, with exhibition of temporal summation and "recruitment" Central after-action, both inhibitory and excitatory, is attributed to temporary persistence of a residuum of the liberated inhibitory or excitatory agent The schema is designed to meet in particular the experimental data furnished by the knee-extensor under crossed excitation and ipsilateral exhibition. It does not attempt to deal with late successive effects such as successive induction and rebound —E G T **Liddell** and Sir Charles **Sherrington**. Recruitment and some other features of reflex inhibition. Under mere prolongation of an otherwise unaltered stimulus of the inhibitory afferent nerve, the central inhibitory process recruits more motoneurones as it proceeds The "stimulation-plateau" of the reflex contraction is more easily inhibited than the "after-discharge plateau" Experiments suggest that a reflex maintains maximal response of the individual "motor-unit" by a degree of central excitation which is commonly "supramaximal," *i.e.* of intensity above the lower limit required for evoking the unit's maximal response In the excitatory reflex a mechanism proximal to the motoneurone axon seems to react in an "all-or-none" manner when exposed to inhibition —D. T **Harris** Studies on the biological action of light Ultra-violet radiations exert a stimulant action on the gaseous metabolism of small animals, and on the movements of the frog's isolated stomach This action is completely annulled by the presence of visible radiations, an action which seems to be physiological antagonism rather than physical interference Exposure of an animal to mixed radiations of a powerful source of light depresses its heat production to an extent greater in pigmented animals than in albinos for the same rise of temperature in the surrounding medium. Thermo-electric measurements indicate that pigment, nevertheless, possesses high absorptive properties Pigment appears to protect an animal against the lethal action of certain photo-dynamic substances —H. **Hartridge** and F J. W **Roughton** The kinetics of hæmoglobin III Velocity with which oxygen combines with reduced hæmoglobin The reaction between oxygen and reduced hæmoglobin is very rapid, the time required for half-completion being 0·01 to 0·001 sec The velocity-constants obtained at P_x 7 and P_x 10, with different concentrations of hæmoglobin and oxygen, agreed in showing that the reaction is bimolecular. The dissociation curve for dilute hæmoglobin solutions is approximately hyperbolic The quotient of the two velocity-constants, oxidation and reduction, is practically equal to the equilibrium constant The presence of hæmoglobin aggregates would not be expected to affect the velocity of oxidation, so long as the part of the molecule with which the oxygen combines is sharply localised and far removed from the aggregate-forming portion This affords an explanation of the low-temperature coefficient obtained.—S. B. **Schryver**, H. W. **Buston** and D. H. **Mukherjee**: The isolation of a product of hydrolysis of the proteins hitherto undescribed By

means of the "carbamate" method, a base $C_6H_{14}O_2N_2$ has been isolated from isinglass. It differs from the other basic products of hydrolysis of the proteins in that it yields a barium carbamate insoluble in water. It gives a tri-benzoyl derivative $C_6H_{11}O_2N_2(C_6H_5CO)_3$ m.p. 68-69°, and it is assigned the formula $CH_2 . (NH_2) . CH_2 \ CH_2 \ CH(OH)CH_2 \ (NH_2) . CO_2H$ It has been found after hydrolysis of fish gelatin, isinglass and three vegetable proteins of very diverse origin. It is absent from, or present only in very small traces in, the hydrolysis products of gelatin of mammalian origin, of casein, fibrin, and egg-white.—D. **Keilin**: On cytochrome: a respiratory pigment common to animals and yeast. Under names myohæmatin and cytohæmatin, McMunn described a respiratory pigment, here named cytochrome Cytochrome, in reduced form, shows a very characteristic spectrum, with four bands (*a*, *b*, *c*, *d*), with positions of maximum intensity *a*, 603, *b*, 565, *c*, 550, *d*, 523. In the oxidised form no absorption bands can be seen In different concentrations cytochrome exists in tissues of all animals, *e g*, worms, molluscs, arthropods and vertebrates It is also present in cells of ordinary baker's yeast, a thin layer of which shows well the above four bands The highest concentration of cytochrome is found in thoracic wing-muscles of insects, striated muscles of mammals, and yeast-cells It yields various derivatives similar to hæmochromogen and its oxy- and CO-compounds, and porphyrin Cytochrome may co-exist with other respiratory pigments, and may be considered an intracellular respiratory pigment, generally distributed, forming part of a complicated system of respiratory catalysts

Royal Microscopical Society (Industrial Applications Section), January 28.—R Stenhouse **Williams** The microscope of fundamental importance to the dairying industry.—Norman **Wright** The structure of the udder, normal and abnormal The solids-not-fat (lactose, protein, and ash of milk) are secreted in very constant concentration, owing probably to their osmotic properties, the fat bears no relation to the other constituents, since, owing to its insolubility, it has no osmotic pressure The control of rate of fat secretion is dependent upon the rate of formation in the gland (probably constant), and the fact that the cell membrane must be penetrated in order to liberate the fat globules The importance of correlation between the constituents of blood and of milk is emphasised.—A T R **Mattick** The enumeration and differentiation of the various cellular elements of milk, by means of the microscope On account of the enormous differences in numbers of cells found in the milk of different cows and even in different quarters of the same cow, no such standard can justly be adopted The method of differentiating between the various types of cells by the use of stains such as Jenners, and finding by means of the microscope the relative frequency of occurrence of the different types, is more promising Whilst the differential method of Varrier-Jones seems to offer considerable promise, more work on the varieties of cells found in different breeds and under different conditions must be done.—L J **Meanwell** The application of the microscope to the detection of tuberculous infection Great care must be exercised before assuming that acid-fast bacilli in market milk are of tubercular origin By the use of the usual routine method of microscopical examination, 20 per cent of infected milks are detected As this method is not satisfactory, animal inoculation must be performed before a report can be given. The disadvantages of the animal inoculation method of examination are said to be (1) Expense, (2) the lapse of time necessary before a report can be given, and (3) the difficulty in tracing the source of infection. 25 per cent. of milking cows are affected with tuberculosis, and in certain districts 4 per cent. of the milking cows show, on post-mortem examination, tuberculous lesions of the mammary gland.—J. **Golding**. Fat globules. "Adsorption films" of the nature of "gels" seem to explain the observations made on milk globules as well as on other emulsions. Observations on the differences in time of churning of the milk of individual cows support the conclusion of other workers that "individuality" may play at least as important a part as "breed" in this respect. The expense and difficulty of accurate estimations of size of fat globules do not encourage the use of the microscope in this direction. The microscopical examination of butter under polarised light yields more definite results in the comparison of butter and margarine.—Miss E R **Hiscox**. The separation and identification of the micro-organisms causing faults in milk products In the first method (moist chamber) a well-isolated cell is kept under observation under the microscope until the resultant colony is large enough to be transferred to a tube of culture medium In the second (Barber's method) small drops of an emulsion of the cells are blown on the lower surface of a coverslip by means of a micro-pipette Drops containing a single cell are transferred to tubes of the culture medium Although physiological reactions are of primary importance in the identification of micro-organisms, microscopical observation of the size and shape (bacteria), form of budding and spore formation (yeasts), form of branching and type of fructification (moulds), may also be of great value

Physical Society, February 13.—F E. **Smith** A system of electrical measurements. The study of the absolute measurement of electrical quantities, though usually regarded as difficult, is not beyond the comprehension of junior students if suitably presented The electrical units as theoretically defined and the practical standards by which they are represented differ, but an incorrect standard can be brought into more precise accordance with its theoretical unit without inconvenience to industry. The increased refinement of measurements calls for a redefinition of the practical standards, and this could be effected without inconvenience, since the most probable values of the standards lie within the limits prescribed by the errors permissible in industrial measurements

PARIS

Academy of Sciences, February 2.—Maurice **Hamy**: The determination of the radial velocities of stars. The application of the Doppler principle to the determination of the radial velocities of stars is now known to require certain corrections The alteration of the wave-length by pressure has been proved, and the Einstein gravitation effect must also be taken into account A. Michelson has also pointed out the necessity for another correction due to the fact that most radiations are not simple An international agreement relating to the comparison lines to be used in the determination of radial velocities is much to be desired.—G. **Bigourdan**: The perturbations of the Hertzian waves during transmission to great distances. A table is given showing monthly, quarterly and annual means; the general mean of the annual values is 0·013 sec.—André **Blondel**: A new method for the harmonic analysis of the curves of electromotive force of alternators. Two methods are described and discussed, one making use of a thermionic amplifier, the other working with a condenser.—Pierre **Weiss**:

The magnetic equation of state and variation of the atomic moment.—M. Eugène Fichot was elected a member of the section of geography and navigation in succession to the late E. Bertin.—A. Kolmogoroff: The possibility of the general definition of the differential, the integral, and the summation of divergent series.—J. Haag: Euclidian action at a distance.—P. Fatou: The movement of a material point submitted to the attraction of a flattened spheroid.—A. Barbaud and R. Le Petit: The measurement of the wind in an aeroplane and its effects on the route followed.—J. Cathala. A recording apparatus for the control of the insulation of enamelled wires. Enamel has been used in late years to an increasing extent as an insulating material for wires, but the wire thus covered always has a certain number of microscopic cracks, where the insulation is nil. In the apparatus described and figured the wire is rapidly drawn through a mercury bath and the weak spots detected.—Léon Guillet and Albert Portevin: The influence of tempering on the mechanical properties of steel after reheating. Whenever the nature of the metal permits the production of different constitutions by tempering, the results of mechanical tests obey the following rule: for equal final hardness after reheating, the resilience is better for the completely tempered states, that is to say, those formed of pure martensite. Inversely, for equality of resilience after reheating, the final hardness is always higher as the temper hardness is higher.—V. Auger and Mlles L. Lafontaine and Ch. Caspar: Some salts of cupferron. Details of the properties of 21 metallic compounds of cupferron.—O. Gaubert: The modification of the facies of crystals as the result of their syncrystallisation with a foreign material dissolved in the mother liquor.—Albert Michel Levy: The birth of biotite in the crushed granites and rhyolites of Morvan.—E. Tabesse. Magnetic measurements in Normandy and Brittany.—H. Hérissey and J. Cheymol. The extraction and properties of geine, a glucoside giving rise to eugenol, contained in *Geum urbanum*. This glucoside was extracted from the fresh underground parts of herb-bennet, in the proportion of about 0·1 per cent. On hydrolysis, it gives eugenol, *d*-glucose and *l*-arabinose in equimolecular proportions.—M. Bridel and C. Charaux: The process of blackening of Orobanche in the course of drying.—L. Blaringhem. New observations on Xenia in wheat.—Ad. Davy de Virville. The biological relations between a liver-wort (*Lophocolea bidentata*) and various Muscineæ.—N. Kleitmann and H. Piéron. The velocity of establishment of the light sensation and the magnitude of the undulation of pre-equilibrium for monochromatic stimulations of variable intensity.—E. Fauré-Fremiet: The quiescent state and active state in the amœbocytes of Arenicola.—C. Hosselet: The œnocytes of *Culex annulatus* and their chondriome in the course of secretion.—C. Levaditi and A. Girard: The mode of action of bismuth in syphilis. A quantitative method has been developed capable of detecting 0·001 milligram of bismuth, and this has been applied to the estimation of bismuth in various organs of the rabbit after treatment with trepol (alkaline tartro-bismuthate). Infinitesimal traces of bismuth (0·002 mgm.) are sufficient to destroy the parasite.

Official Publications Received.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 10: Statistics of Teachers Colleges and Normal Schools, 1921–22. Prepared under the Direction of Frank M. Phillips. Pp. 76. 10 cents. Bulletin, 1924, No. 22: Technique of Procedure in Collegiate Registration. By Prof. George T. Avery. Pp. 26. 5 cents. Bulletin, 1924, No. 24: Organization and Administration of the Duplicate School in Philadelphia, Pa. By Edwin Y. Montanye. Pp. 16. 5 cents. Bulletin, 1924, No. 25: A Platoon School in Kansas City, Missouri. By G. W. Diemer. Pp. iii+26. 5 cents. (Washington: Government Printing Office.)

United States Department of Agriculture: Department Bulletin No. 1318: Fumigation against Grain Weevils with various Volatile Organic Compounds. By Ira E. Neifert, F. C. Cook, R. C. Roark, W. H. Tonkin, E. A. Back and R. T. Cotton. Pp. 40. (Washington: Government Printing Office.) 10 cents.

Contributions from the Princeton University Observatory, No. 7. Photometric Researches: The Eclipsing Variables, TV Cassiopeiæ, TW Cassiopeiæ, TX Cassiopeiæ, T Leonis minoris, 88 Camelopardalis. By Richard John McDiarmid. Pp. 64. (Princeton, N.J.)

Bulletin of the National Research Council. Vol. 8, Part 2, No. 44: The Continental Shelf off the Coast of California. By Andrew C. Lawson. Pp. 23. 25 cents. Vol. 8, Part 4, No. 46. The Geological Implications of the Doctrine of Isostasy. By Andrew C. Lawson. Pp. 22. 40 cents. (Washington: National Academy of Sciences.)

Cornell University Agricultural Experiment Station. Memoir 68. The Lepidoptera of New York and neighboring States. Primitive Forms, Microlepidoptera, Pyraloids, Bombyces. By William T. M. Forbes. Pp. 729. (Ithaca, N.Y.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1924. Pp. vi+200. (Washington: Government Printing Office.) 60 cents.

International Geodetic and Geophysical Union (Union Géodésique et Géophysique Internationale). Section of Terrestrial Magnetism and Electricity. Bulletin No. 4. Terrestrial Magnetism and Electricity at the Madrid Meeting, October 1924, General Report. By Louis A. Bauer. Pp. 10. (Baltimore, Md.: Johns Hopkins Press.) 25 cents.

Department of the Interior, Canada. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 3, No. 1. The Absolute Magnitudes and Parallaxes of 1105 Stars. By R. K. Young and W. E. Harper. Pp. 143+4 plates. (Ottawa: F. A. Acland.)

Journal and Proceedings of the Royal Society of Western Australia. Vol. 10, 1923–1924. Pp. xxvii+129+11 plates. (Perth.)

Department of Commerce. U.S. Coast and Geodetic Survey. Serial No. 275. Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Md., in 1921 and 1922. By Daniel L. Hazard. Pp. 96+5 plates. (Washington: Government Printing Office.) 10 cents.

Legislative Assembly: New South Wales. Report of the Director General of Public Health, New South Wales, for the year 1923. Pp. v+157+19 graphs. (Sydney: Alfred James Kent.) 7s. 3d.

Ministry of Finance, Egypt. Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the year 1923. By G. W. Paget. Pp. v+43. (Cairo: Government Publications Office.) 5 P.T.

Instituts Scientifiques de Buitenzorg: 's Lands Plantentuin: Treubia. Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Rédigé par Dr. W. M. Docters van Leeuwen, Dr. K. W. Dammerman et Dr. H. C. Delsman. Vol. 5 Supplement, Septembre 1924. Pp. 142+5 Tafeln. (Batavia: Landsdrukkerij).

Department of Agriculture, Ceylon. Bulletin No. 70. Guide to the Central Experiment Station, Peradeniya. By T. H. Holland and H. A. Deutrom. Pp. 112+6 plans. Bulletin No. 71. Entomogenous Fungi and their Use in Controlling Insect Pests. By T. Petch. Pp. 40+2 plates. (Colombo.) 40 cents each.

Union of South Africa: Department of Agriculture. Science Bulletin No. 34. Kemp Fibres in the Merino Sheep. By Prof. J. E. Duerden and Miss M. Ritchie. Pp. 11+18. (Cape Town: *Cape Times*, Ltd.) 5d.

South Australia: Department of Mines. Mining Review for the Half-year ended June 30th, 1924. (No. 40.) Pp. 66+5 plates. (Adelaide: R. E. E. Rogers.)

Ministry of Agriculture, Egypt. Technical and Scientific Service. Bulletin No. 53. The Effect of Irrigation upon Soil Temperatures. By Dr. E. McKenzie Taylor. Pp. 18+7 plates. Bulletin No. 51: A Statistical Note on the Cotton Variety Tests at Sakha, 1916–1920. By Trevor Trought. Pp. 16. (Cairo: Government Publications Office.) 5 P.T. each.

Torquay Natural History Society. Transactions and Proceedings for the Year 1923–24. Edited by the Rev. James A. Balleine and H. L. Farr. Vol. 4, Part 2. Pp. 101–198. (Torquay.)

The Carnegie United Kingdom Trust. Eleventh Annual Report (for the Year ending 31st December 1924) submitted by the Executive Committee to the Trustees on Friday, 27th February 1925. Pp. ii+89. (East Port, Dunfermline.)

Smoke Abatement League of Great Britain. Report of the Smoke Abatement Conference held at the Town Hall, Manchester, November 4th, 5th and 6th, 1924. Pp. xi+308. (Manchester: Hon. Secretary, 33 Blackfriars Street.) 5s. 6d.

Diary of Societies.

SATURDAY, MARCH 21.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11 A.M.—Miss E. Green: The Development of Zygorhynchus.—W. F. Hanna: Sex in the Genus Coprinus.—J. Ramsbottom: Fragmenta Mycologica III.—Dr. M. C. Rayner: Sectoring in Cultures of *Phoma radicis-Callunæ*.—Miss A. Lorrain Smith: (I.) Notes on Myxobacteriaceæ, (II.) Templeton's Drawings of Fungi and Lichens.

PHYSIOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—E. H. J. Schuster: Adjustable Pump for Artificial Respiration or Perfusion.—A. C. Downing: (*a*) Magnet Systems for Sensitive Galvanometers, (*b*) Some Recent Muscle Thermopiles, (*c*) A Sensitive Compton Electrometer.—N. Kubo and Prof. A. V. Hill: The Effect of Length on the Heat-production of Muscle.—Phyllis M. Kerridge: Modified Glass Electrodes.—J. Wyman: The Viscous-elastic Properties of Tortoise's Muscle.—W. Shaw: The Relation of the Corpus Luteum to the Pre-menstrual Changes of the Endometrium.—J. R. Pereira: The Patellometer: Measurement of the Threshold Stimulus and Recording of the Knee-jerk.—D. T. Harris: Action of Light on the Affinity of Hæmoglobin for Oxygen.—W. K. Slater: A Micro-respiration Apparatus.—H. A. Ellis: A Rapid Colorimetric Method of Measuring the C_H of Blood.—Dr. C. Da Fano: Modification of the Hewer Method for Staining in Bulk with Hæmatoxylin and Eosin.—H. I. Coombs and T. S. Hele: The

Effect of Phenols on the Sulphur Metabolism of the Dog.—Prof. J. S. Macdonald. Rectal Temperatures observed in Cycling Experiments.—W. Smith and L. B. Winter. Insulin and Micro-organisms.—L. N. Katz and C. N. H. Long: A Comparison of the Lactic Acid Content of Heart and Skeletal Muscle after Stimulation and in Rigor Mortis.—Prof. T. H. Milroy: Carbohydrate and Phosphate Metabolism in Muscles during Hyperglycæmia.—J. Hoet. The Action of Atropine on the Gut.—F. Avaling, R. J. S. McDowall, and H. Wells: The Physiology of the so-called "Psychogalvanic Reflex."—A. St. G. Huggett and Prof. J. Mellanby. The Action of Adrenalin, Ergotamine, and Curare on Muscle Tonus and Decerebrate Rigidity.—Dr. G. V. Anrep: Observations on Pulmonary Circulation.—H. N. Segall: The Isometric Contraction and Relaxation of the Frog's Heart.—Dr. G. V. Anrep and H. N. Segall: The Bainbridge Reflex.—H. E. Kinnersley, R. A. Peters, and J. T. Squires: Animal Quinoidine.—G. S. Adair: The Equilibrium of Oxygen and Hæmoglobin.

British Psychological Society (at Bedford College, Regent's Park), at 8.—R. H. Thouless: The Physics of the Psychogalvanic Reflex Phenomenon.—Rev. R. C. McCarthy: The "Determining Tendency" and Conation.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (IV.).

Institute of British Foundrymen (Lancashire Branch: Junior Section) (at Manchester College of Technology), at 7.—H. Stead: Plate Moulding and the Patternmaker.

Hull Association of Engineers (at Hull Technical College), at 7.15.—Elce: Steam Turbines.

Ipswich and District Natural History Society (at Ipswich).—Dr. H. M. Cade. The Germ Theory of Disease (Pathogenic Bacteria).

MONDAY, March 23.

Royal Society of Edinburgh, at 4.30.—Dr. A. Balfour: *Reflections on Malaria*.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—W. J. Bryan: Man and the Divine Image.

Royal Society of Medicine, at 5.30.—Dr. W. Hunter, Dr. R. Hutchinson, and others. Special Discussion (continued from February 16) on Non-specific Disturbances of Health due to Vitamin Deficiency.

Institute of Chemistry (Leeds Section) (at Leeds University), at 7.—R. B. Pilcher: Alchemists and Chemists in Art and Literature.

Institution of Electrical Engineers (*Informal Meeting*), at 7.—H. Grierson and others. Discussion on Panel Heating.

Institution of Electrical Engineers (North-Eastern Centre) (at Mining Institute, Newcastle-on-Tyne), at 7.15.—Col. T. F. Purves: The Post Office and Automatic Telephones.

Royal Scottish Society of Arts (at 117 George Street, Edinburgh), at 8.—Prof. W. Peddie: The Construction of Solid Materials.

Royal Society of Medicine (Odontology Section), at 8.—G. J. Harborow: A Dental Cyst in Connexion with a Deciduous Tooth.—A. Livingston: The Permeability of Enamel.

Royal Geographical Society (at Æolian Hall), at 8.30.—F. G. Binney: Across North-East Land.

Medical Society of London, at 8.30.—L. B. Rawling, Sir William Willcox, and others: Discussion on Oxaluria.

TUESDAY, March 24.

Royal College of Physicians of London, at 5.—Dr. J. A. Ryle: The Study of Gastric Function in Health and Disease (Goulstonian Lectures) (III.).

Royal Institution of Great Britain, at 5.15.—Prof. A. S. Eddington: The Internal Constitution of the Stars (I.).

Institution of Civil Engineers, at 6.—P. W. Robson: The Large Water-tube Boiler.

Institution of Electrical Engineers (East Midland Sub-Centre) (at University College, Nottingham), at 6.45.—Major E. I. David: Electricity in Mines.

Institution of Automobile Engineers (Informal Meeting) (at 83 Pall Mall), at 7.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

Royal Photographic Society of Great Britain, at 7.—J. F. Young: Perspective.

Institution of Automobile Engineers (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—C. Walker: Automobile Steels and Irons.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—Discussion on Internal Combustion Turbines, Prof. W. J. Goudie, and The Manufacture of Brass Condenser Tubes, with some Notes on an Alternative Alloy, G. H. Whiteman and A. Spittle.

Royal Society of Medicine (Surgery, Medicine, and Pathology Sections), at 8.—Sir Thomas Horder (Medicine), R. P. Rowlands (Surgery), and others. The Treatment of Septicæmia.

Royal Anthropological Institute (at 52 Upper Bedford Place, W.C.1), at 8.15.—Sir Aurel Stein: Innermost Asia. Its Geography as a Factor in History.

WEDNESDAY, March 25.

Geological Society of London, at 5.30.—C. Barrington Brown and R. A. Baldry: The Clay Pebble Bed of Ancon (Ecuador).—J. I. Platt. The Pre-Cambrian Volcanic Rocks of the Malvern Inlier.

Institution of Civil Engineers (*jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association*), at 6.—W. H. Patchell: A Standard Code for Tabulating the Results of a Steam-Generating Plant Trial.

Institution of Automobile Engineers (North of England Centre) (at 244 Deansgate, Manchester), at 6.30.—A. P. Burstall: Experiments on a High-speed Gas Engine.

North-East Coast Institution of Engineers and Shipbuilders (Newcastle and Middlesbrough Graduate Sections) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—Calderwood: The Possible Influence of Recent Research on Propeller Design.

Society of Chemical Industry (Newcastle Section) (at Armstrong College), at 7.30.—F. H. Walker: The Sampling of Coal.

Royal Microscopical Society (Industrial Applications Section), at 7.30.—Dr. J. A. Murray: The Making of Microscopical Preparations: (II.) Imbedding and Section-cutting.—Prof. P. Groom: The Microscopical Investigation of Fungal Attacks on Wood.—A. P. H. Trevelli and R. P. Loveland: The Application of Microscopy to the Photographic Industry.

Royal Society of Arts, at 8.—H. G. Dowling: Wall-papers.

British Psychological Society (Medical Section) (at Royal Society of Medicine), at 8.—Dr. J. A. Hadfield, Dr. J. Glover, and A. F. Shand: Discussion on The Conception of Sexuality.

THURSDAY, March 26.

Royal Society, at 4.30.—Prof. O. W. Richardson and T. Tanaka: *Regularities in the Secondary Spectrum of Hydrogen*.—Prof. S. Chapman. The Lunar Diurnal Magnetic Variation at Greenwich and other Observatories.—H. T. Flint: A General Vector Analysis with Applications to Electrodynamical Theory.—Miss M. O. Saltmarsh: The Spectra of Doubly- and Trebly-Ionised Phosphorus (P III and P IV).—*To be read in title only*: Dr. D. M. Wrinch and Dr. J. W. Nicholson: Laplace's Equation and the Inversion of Surfaces of Revolution.—Prof. T. R. Merton and J. G. Pilley: Experiments relating to the Spectrum of Nitrogen.—Prof. T. H. Havelock: Studies in Wave Resistance: the Effect of Parallel Middle Body.—T. Tanaka: Wave lengths of Additional Lines in the Many-lined Spectrum of Hydrogen.

Royal College of Physicians of London, at 5.—Dr. H. Cameron: Some Forms of Vomiting in Infancy (Lumleian Lectures) (I.).

Royal Institution of Great Britain, at 5.15.—T. Thorne Baker: Chemical and Physical Effects of Light (I.).

Royal Aeronautical Society (at Royal Society of Arts), at 5.30.—Dr. Eckener: Modern Zeppelin Airships.

Institute of Chemistry (Belfast Section) (at Queen's University, Belfast), at 7.30.—Dr. W. H. Gibson. The Union of Chemical Societies.

Institution of Automobile Engineers (Luton Graduates' Meeting) (at Luton), at 7.30.—Gibson: Maximum Performance and Balance of a Four-cylinder Engine.

FRIDAY, March 27.

Royal Sanitary Institute (at Town Hall, Leicester), at 3.30.—Dr. Helen Dent, Mrs. C. J. Bond, and others: Discussion on Maternity and Child Welfare Work.

Physical Society of London (at Imperial College of Science and Technology), at 5.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimen illustrating the Commoner Congenital Malformations of the Lower Limb.

Royal Sanitary Institute (at Town Hall, Leicester), at 5.30.—Discussion on Smoke Abatement.

Institute of Marine Engineers, at 6.30.—Annual Meeting.

Manchester Literary and Philosophical Society (Chemical Section) (at 36 George Street, Manchester), at 7.

Institution of Mechanical Engineers (Informal Meeting), at 7.—Discussion on The Cutting of Heavy Steel Sections.

Royal Photographic Society of Great Britain, at 7.—H. Felton: *The Thames (Lecture)*.

Junior Institution of Engineers, at 7.30.—A. P. Morris: Irrigation Engineering in Burma.

North-East Coast Institution of Engineers and Shipbuilders (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—Eng. Lieut. Comdr. L. J. Le Mesurier. Conversion of the s.s. *Binsang*.

North East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—S. Stanefield. Investigations of Stresses in the Rotating Parts of Steam and Internal Combustion Engines.

Royal Sanitary Institute (at Town Hall, Leicester), at 8.—Prof. H. R. Kenwood. Healthy Living—Facts and Fads (Lecture).

Royal Institution of Great Britain, at 9.—Sir Ernest Rutherford: Studies of Atomic Nuclei.

SATURDAY, March 28.

Royal Institution of Great Britain, at 3.—Prof. J. H. Ashworth: The Nervous System and Some Reactions (I.): Of Ciliate Protozoa and Sea Anemones.

PUBLIC LECTURES.

SATURDAY, March 21.

University College, at 3.—Dr. F. M. Feldman: Post-Natal Child Physiology and Hygiene (Chadwick Lecture).

Horniman Museum (Forest Hill), at 3.30.—S. Hazzledine Warren: Who were the First Men?

WEDNESDAY, March 25.

University College, at 5.30.—Prof. T. B. Wood: The Nutrition of the Young Animal (III.).

THURSDAY, March 26.

South Place Institute (South Place, Moorgate, E.C.), at 7.—Sir Arthur Keith: The Religion of a Darwinist (Moncure Conway Memorial Lecture).

SATURDAY, March 28.

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Living Animals of the Sea Shore.



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Editorial and Publishing Offices.
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NO. 2891, VOL. 115]

Scientific Officers in Tropical Agriculture.

MR ORMSBY-GORE, Parliamentary Under-Secretary of State for the Colonies, speaking at the annual dinner of the National Union of Scientific Workers on March 19, emphasised the need for many more highly trained scientific officers in British colonial possessions. His recent visit to East Africa with Major Church, secretary of the Union, as members of the East African Parliamentary Commission, revealed to him some of the problems which could be solved only by the use of scientific knowledge, and developments which can come from scientific guidance alone He regarded the present position as to officers and institutions concerned with tropical agriculture as "a disgrace to the Empire"

The earliest appointments of this class of scientific officers in tropical agriculture were the heads of the various tropical botanic gardens, usually systematic botanists, whose concern with agriculture was only a limited one, their principal duties being the introduction of possible useful plants, and the investigation of the local flora The first officer of a more specialist type to be appointed in the British tropical colonies was the late Prof Marshall Ward, who was sent to Ceylon in 1882 to investigate the coffee leaf disease (*Hemileia vastatrix*) and to endeavour to find some remedy for the already desperate position of affairs But his advent upon the scene was much too late for any remedy to be applicable that was within the means of the planters, and the visit was unsuccessful, so that public opinion was set against such appointments. A little later, however, the well-known Dr. Treub obtained quite a considerable staff of specialist scientific officers at the great Dutch colonial institute in Java, to which Mr. Ormsby-Gore paid high tribute

For a long time no further appointments were made in the British tropical colonies, and the next, so far as we are aware, was that of Mr E. E Green (now president of the Entomological Society), who in 1897 was made honorary government entomologist in Ceylon, with a small grant for expenses. In the following year, Mr. J. Parkin was appointed assistant in Ceylon to investigate the chemistry and physiology of the coagulation of rubber latex Mr. Green did such valuable work in his honorary capacity that in 1899 he was appointed full-time entomologist, while in the same year the newly formed Imperial Department of Agriculture in the West Indies appointed Mr. Maxwell Lefroy (now professor at the Imperial College of Science, South Kensington) as entomologist, and Messrs Harrison and d'Albuquerque as honorary chemists.

From that time onwards the number of scientific men employed in the tropical colonies has steadily increased,

though at first public opinion was opposed to such appointments, on the supposition that scientific work was unlikely to have much bearing upon practice in agricultural matters This expansion is to some slight extent due to an element of good fortune which attended these pioneers, who were markedly successful in their early work, of which that of the first two may be quoted as an example Mr. Green, with years of practical experience as a tea planter, made recommendations for the treatment of disease which were at once practical, economical, and successful, while Mr Parkin devised the method of coagulation of rubber latex which is still followed At first, the appointments were chiefly of officers to deal with diseases, or of chemists to deal with soil questions, and in this and other ways the old botanic gardens in some of the most important tropical colonies developed into Departments of Agriculture.

There are several essentials in the equipment of a scientific officer for the tropics, though naturally the training of each must vary with the duties which he is to undertake These essentials are well set forth by Prof Farmer in a pamphlet recently issued [1] In the first place, the officer must, of course, have a thorough knowledge of the science with which he is to be concerned, a knowledge best obtained at one of the universities, where he should have taken a good degree in honours. Next in importance is a good general knowledge of tropical agriculture, and (especially in the case of officers like entomologists, who have to make recommendations which involve the outlay of money) of the economics of the various cultivations. Such knowledge is best obtained in a tropical country, and if the individual cannot afford to spend some time at such a place as the Imperial College of Tropical Agriculture in Trinidad, he should learn his work by being attached as assistant to some officer with long experience of the tropics In the third place, the man should have a capacity for research, sufficient at any rate to enable him to find out the life-history of a disease, to test new plants or new conditions, to advise as to the best manures for unfamiliar soils, and such matters While this capacity is largely inborn, it may be much improved by work under a capable and experienced chief, under whom he may carry out definite pieces of research Finally, a most desirable part of the equipment is a capacity for giving—in speaking or in writing—clear and easily understood accounts of any work that has been carried out, whether his own or that of other workers It is through the work of men of this type, adequately trained and reasonably paid, that, as Mr Ormsby-Gore remarked, "we shall be justified in history as a great Imperial Power"

[1] "On the Training of Scientific Officers for Tropical Plantation Industry," by Prof J B Farmer Reprinted from the Official Report of the Brussels Conference, 1924, published by the Rubber Growers' Association, Inc.

Philosophy and Science.

The Scientific Approach to Philosophy: Selected Essays and Reviews. By Prof. H. Wildon Carr. Pp viii+278. (London: Macmillan and Co., Ltd, 1924.) 12s. net.

FOR centuries past, science and philosophy, in spite of their common origin in the evolution of human thought, in spite, also, of the continuous (and inevitable) influence of each upon the other, have slowly but steadily drifted apart, both as regards their method and supposed subject-matter and as regards the avowed aims and general attitude of mind of their respective exponents During the past twenty years, however, there has been a marked reversal of this tendency; and it is fitting that Prof Wildon Carr should be one of the first to publish a systematic explanation of the causes and significance of the new movement, for he has done as much as any man to foster and encourage it.

Prof. Wildon Carr begins by pointing out that science and philosophy differ, not in their subject-matter, but in the mind's attitude towards it Philosophy seeks to see reality as a whole, but science is more concerned with particulars Philosophy proceeds from the whole to the parts, regarding the latter as significant only in their relation to the whole. Science, on the other hand, considers the parts as having reality in their own right, and proceeds, not to a systematic whole, but to invariable laws. It should perhaps be remarked that this view of the relation between science and philosophy is in fundamental contrast to that held, for example, by Mr. Bertrand Russell. For Mr. Russell, science and philosophy start from the same point and with the same material, namely, the particular facts of experience, and it is these particulars and the relations which subsist between them which are the essential concern of both. The difference between them lies in the fact that they proceed from their starting-point in opposite directions.

Prof Wildon Carr considers that science and philosophy have reapproached through biology and electromagnetism, or, more particularly, through evolution and relativity. The dichotomy of Nature as objective reality and mind as ideal representation, assumed by science, has turned out unworkable. Progress in science has raised, in connexion with science itself, metaphysical problems which are compelling us to reconstruct the whole basis of scientific thought The reproach, so often levelled at philosophy, that it is concerned with mere speculation regarding a transcendent reality, whereas science provides comparative certainty, is held by Prof. Wildon Carr to be due to the nature of the older idealisms. The "New Idealism," on the contrary, is the consciousness that the problems of science and philosophy arise from the

same subject-matter. It is in fundamental opposition to the "New Realism," for it regards activity and becoming as original, objects of ordinary experience as derived, and physical concepts as constructed; whereas the new realism assumes mind to be passive to the revelation of an external reality and active only in so far as it attends to what is thus presented.

Bergson and Croce are taken as the chief exponents of the new idealism The importance of Bergson lies in his substitution of the concept of pure duration for that of pure extension This implies that reality is fundamentally psychical, for only what is psychical "endures." Prof Wildon Carr goes on to a discussion of Bergson's theories of mind-energy and of memory, in the course of which he indicates what, in the present writer's view, is a complete refutation of the theory (still held by some men of science) that brain produces mind Briefly, his argument is that the theory in question leads to a contradiction and a vicious circle, for it can only infer the existence of the external world from the existence of brain process, while at the same time it is compelled to infer brain process from the existence of the external world of which the body is a part

There follows an interesting exposition of Croce's main theses, namely, that philosophy is not a science with a special (abstract) subject-matter, but a way of studying reality in its most comprehensive sense, while history is not the record of what was, but the interpretation of what is Hegel discovered the logic of philosophy—a special method of treating reality as a whole and not particular parts thereof; but he is criticised by Croce for failing to recognise that there are analogous logics of mathematics, science, history, etc., and for confusing the synthesis of contradictions with degrees of truth and reality

That portion of the book which deals with relativity will perhaps be of most interest to the scientific reader General relativity theory, if accepted, means the convergence of the two lines of intellectual development which we name science and philosophy. It reforms the notions of substance (ether) and cause (force), and implies that reality is "monadic" (*i.e.* constituted by "monads" or "minds" considered as metaphysical reals), the "universe" of physics and common-sense being dependent on subjects of experience in the sense that it is the co-ordination which they effect. In the result, materialism and natural realism cannot be indifferent to relativity, for their whole philosophy is at stake.

For philosophy in general, Einstein's scheme is superior because its constitution is inherent in experience and does not transcend the conditions thereof. It rejects an absolute *which is independent of experience*, and recognises as fundamental one of the chief tenets of monadism, namely, that there is no way of presenting the object of knowledge in complete detachment from the conditions of knowing

After an illuminating review of the work of Descartes and Pascal, Prof. Wildon Carr concludes with a discussion of intercourse by means of speech. The problem here considered arises from the fact that individual experience is private and yet there is intercourse The author argues, in this connexion, that language is not an invention due to our reasoning powers, but a product of evolution We speak because we are organised to produce and respond to articulated sounds Language is dependent on an internal psychical structure—we reason because we speak, and not vice versa

It is in respect of this problem of intercourse and interaction between minds that a weakness appears in Prof Wildon Carr's theories, and particularly with regard to the relation of body and mind, where it is argued that theory of intercourse is impossible if mind and body are distinct. But the difficulties of regarding mind and body together as one individual monad are very great For example, such a view cannot account satisfactorily for the fact that the mind's relation to the body has a twofold character. On one hand, a mind's relation to its own body is quite different in certain obvious respects from its relation to any other body, but, on the other hand, in no less obvious respects it is related to its own body (*e.g.* when it sees it) in the same way as it is related to all other material bodies. In fact, here and elsewhere, when dealing with this problem of intercourse and all that it implies, Prof Wildon Carr seems too prone to conceive interaction solely on the model of mechanical interaction. Indeed, on p 277 of his present work he says quite definitely that "intercourse between monads cannot be conceived as a form of *mechanical* interaction" But, quite apart from the fact that, if what he says about relativity is true, there is, strictly speaking, no such thing as *mechanical* interaction, he has not, in the writer's opinion, succeeded in proving that intercourse between monads may not be a type of relation which can fairly be termed "interaction," where action or activity is used in the sense in which he himself uses it, of monads or psychical reals, and not in the mechanical sense.

The book is written in Prof Wildon Carr's usual clear and eminently readable style. Though it consists of a number of papers given originally in comparative independence of one another, the thread of the author's thought is continuous throughout The theme of his study is of the greatest importance at the present time, and cannot fail to be of interest to all who wish to appreciate the real significance of the new convergence of those two streams of thought which have produced at intervals what are perhaps the noblest and mos profound creations of the human mind. C A R.

Chemistry and the Quantum Theory.

A System of Physical Chemistry. By Prof. William C. McC. Lewis. (Text-Books of Physical Chemistry.) Third edition. In 3 vols. Vol. 3: *Quantum Theory*. With certain Appendices by James Rice, A M'Keown, and R. O. Griffith Pp x+407. (London: Longmans, Green and Co., 1924.) 15s. net.

AN important test of the value of a scientific theory is its comprehensiveness. It is a curious and, in some ways, a significant fact that the most detailed account of the quantum theory published in Great Britain (apart from translations) is written by a professor of physical chemistry and appears in a series of text-books devoted to that subject There are signs that the boundary lines between "classical" physics and chemistry, almost unknown to Faraday, will again be obliterated and the two subjects become united in a theory of wider generalisation An Armstrong and an Arrhenius may worship together in a more magnificent temple dominated by the genius of Niels Bohr Chemists and physicists will no longer use different names for the same thing, but hark back to the point of view of Faraday, thus expressed by Poynting: "The hypothesis with which we start is that electrical and chemical forces are identical, that electrification is a manifestation of unsatisfied chemical affinities and that chemical union is a binding together of oppositely charged atoms or groups of atoms"

We are all agreed that matter may be described as composed of light negative electrons and more massive positive electrons or protons. We are all agreed that radiation may be regarded as an electromagnetic disturbance. To complete the picture we are forced by experimental facts to accept the two main postulates of Bohr: (1) Atomic systems can exist in certain "stationary states" which may be discussed by help of the ordinary electrodynamics in association with the appropriate quantum restrictions; (2) the passage of the systems between different stationary states cannot be treated by the classical theory, but involves, in some unexplained way, the emission or absorption of an amount of homogeneous radiation defined by the energy quantum $h\nu$, the product of Planck's constant h and the frequency ν. The foundations of the theory are discussed in an able manner in the appendices to the volume under review, and a special word of praise must be given to the lucid account of the "correspondence principle" by Prof James Rice Bohr's first postulate leads directly to the conception of energy levels, each such level being appropriate to a particular arrangement of the constituent charges of atom or molecule. It may be well to emphasise the importance of this conception in connexion with the problem of reaction velocity discussed by Marcelin and by Rice. The applications of the second postulate described in the volume are many, and it is possible to refer only to two which have recently attracted much attention.

The important photo-chemical law formulated by Einstein (1912) may be stated as follows: When light of frequency ν is incident on a system sensitive to such light, for each quantum of energy ($h\nu$) absorbed, one molecule of the absorbing substance is decomposed. It follows, according to this law, that the amount of substance acted upon by the light is proportional to the product of the absorbed radiant energy and its wave-length, and is independent of all other factors such as temperature. Most photo-chemical processes are complicated by secondary reactions which render it extremely difficult to test the direct applicability of the law It is, however, now generally admitted that *the absorbing molecule* absorbs energy in quanta. The experimental evidence is discussed in Appendix VII. by R. O. Griffith, who concludes that the ratio of the number of molecules decomposed to the number of quanta absorbed may vary over wide limits, though in a large number of cases its value is not far removed from unity. In a few reactions and within certain narrow spectral limits the ratio has been found to be unity. In the photo-chemical decomposition of hydrobromic and hydriodic acids, one quantum brings about the decomposition of two molecules, one molecule being decomposed directly, the other by a secondary process. But, in general, the ratio above mentioned is determined by processes which occur between the act of absorption and the production of the final products. Thus the final conclusion reached may be stated by saying that there is strong evidence in favour of the view that the ratio of the energy absorbed to $h\nu$ is equal to the number of absorbing molecules, but this number may differ considerably from the number of molecules decomposed. It is, accordingly, extremely probable that the primary process consists in the absorption of an energy quantum, but the subsequent changes are frequently so complicated that it is not at present possible to express them in terms of the quantum theory

The second question of great interest is the radiation hypothesis of chemical change first suggested by Trautz and discussed later by Perrin and the author of the present volume. Whilst the hypothesis accounts satisfactorily for the influence of temperature upon the velocity constant, it has not yet been shown that the hypothesis is capable of accounting for a velocity constant itself, the observed velocities being greatly in excess of those required by the hypothesis. Prof. Lewis sums up the position (in 1923) in a very fair way, without coming to any definite conclusion. He points out that the true analogue of thermal chemical change

on the radiation hypothesis is the thermionic effect, consisting in the emission of electrons due to the temperature of the material itself, and consequently due to the radiation density of all wave-lengths characteristic of the temperature of the material. The analogue of photo-chemical change is the photo-electric effect, in which electrons are emitted from a material owing to exposure of the surface to radiation from an external source at a relatively high temperature and usually of relatively short wave-length.

The reviewer has carefully compared the new edition with that of 1919 and finds that not only has the size of the volume been doubled but many desirable alterations and corrections have also been made. There are some points which require correction, but as the author remarks with truth, in such a rapidly changing subject it is exceedingly difficult to carry out the process of selection and condensation in a satisfactory way. Whilst the book cannot be described as a work of the very first rank, no serious student of advanced chemistry or physics can afford to overlook it. H. S. ALLEN.

Among the Natives of East Africa.

Beneath African Glaciers: the Humours, Tragedies, and Demands of an East African Government Station as experienced by an Official's Wife; with some Personal Views on Native Life and Customs By Anne Dundas. Pp. 238 + 28 plates. (London: H. F. and G Witherby, 1924.) 12*s.* 6*d.* net.

MRS. DUNDAS, as the wife of one of the Chief Commissioners (in the Kilimanjaro district), has had special opportunities for studying native problems on the spot, and these opportunities she has used to the utmost. It is admirable the ease with which she adapts herself to novel surroundings, making the best of everything, seeing something of interest in every place and object, whether at home or on the march. This is no small achievement when one considers the multitude of discomforts which have to be contended with in the climate of equatorial Africa; yet with a mind so active and so fully occupied with all that is going on around her, she is fortunate in having little time to dwell on these matters. Her sympathy with the inhabitants, and her power of expressing, in clear and pleasant language, the results of her observations and the conclusions she has come to, add a charm which is not often found in a book of this description. Existing and prospective officials, whose fate it may be to govern primitive races, could not do better than study closely what she has to say.

It is quite refreshing to read of the unsophisticated life the natives of this country lead—apparently happy—unspoilt, as yet, by the professional agitator, who earns his living by disturbing the "natural true contentment of spirit" in which man lives. The chapter on missionaries and their ways, and the conclusions the author comes to, are of much interest because of the important influence they are sometimes able to exert on the destinies of uncivilised people. One cannot help thinking that the author's views are sound common sense. What missionaries should do, when they begin to work among primitive races, is to devote all their energies to educating them, without trying to convert them, and without interfering with their native customs, for the latter often has the effect of undermining the authority of their chiefs through whom it is our policy to govern; any interference necessary in this direction should be left to government.

Mrs Dundas puts all this very well, and we must leave it to her readers to see how she does it. We may say, however, that her views appear to be those of a thoughtful inquirer, even on such a delicate subject as polygamy, deserving the closest attention of all who really have the welfare of native races at heart, and we hope her writings will bear some fruit. It is not the first time missionary methods have been criticised, but we are not sure criticism has produced much effect.

Mrs. Dundas has a good deal to say about Kilimanjaro, Africa's highest mountain, in sight of which she spent so much time. Two chapters are devoted to native manners and customs, and one to "big and little game" The book is well illustrated by scenes from life in Tanganyika, but a map is badly wanted, and if the volume is ever reprinted one should certainly be added. H. L. C.

Our Bookshelf.

L'Isotopie et les éléments isotopes. Par Mme. Pierre Curie. (Recueil des Conférences-Rapports de Documentation sur la Physique Vol. 9, 2e série, Conférences 1, 2, 3. Édité par la Société *Journal de Physique*) Pp. 210. (Paris. Les Presses universitaires de France, 1924.) 22·50 francs.

THE announcement that the first series of reports published under the auspices of the *Journal de Physique* was to be followed by a second series must have been welcomed by many physicists, to whom the task of keeping abreast of the manifold developments of the subject has become of daily increasing difficulty. The editors have been fortunate in their choice both of author and subject for this opening volume of the second series. There can be no doubt of the authority with which Mme. Curie speaks in all matters radioactive, or of her ability to marshal and expound her facts in a manner which makes them easy to grasp and assimilate. The fact that she has not been personally concerned in the more startling of the discoveries which she has to narrate is an additional advantage, as it has enabled her to exercise a critical discrimination not so

easily attained by one more intimately connected with the development of the subject.

The present volume is admirable, and covers a considerably wider field than might be expected from its title. It opens with an excellent synopsis of the chemistry, electrochemistry, and classification of the radio-elements leading up to a study of the radioactive isotopes. The following section deals with the isotopes of the non-radioactive elements, and the experiments of Aston, Dempster, and others. A third brief section is devoted to some interesting speculations on the structure of the atomic nucleus, and the volume concludes with a critical account of the methods adopted or proposed for separating the pure isotopes from the mixed element.

A full bibliography is appended Unfortunately, there is no index. The book is clearly printed and well illustrated with diagrams and plates, and its value is enhanced by numerous well-displayed tables. Mme Curie has collected in these 210 pages a mine of information, much of which can only be consulted elsewhere in original publications Both physicists and chemists should find this volume a valuable addition to their bookshelves. J. A. C.

Electrical Machinery and Control Diagrams. By T. Croft. Pp. xii+305. (London: McGraw-Hill Publishing Co., Ltd., 1924) 15s. net.

In practice, an electrician sometimes merely requires a circuit diagram of the apparatus or equipment with which he is working. He must therefore use symbols to denote electric bells, dynamos, etc., and show how they are connected with the accessory apparatus, such as switches, fuses, and regulating resistance coils. It is of importance that standard symbols should be internationally adopted. Considerable progress has been made in this direction by the International Electrotechnical Commission, and the leading countries of the world have sent in suggested symbols. Complete agreement, however, has not yet been obtained.

The symbols adopted by the author are those used by the Electric Power Club of America. They are very similar to those used in other countries. The 500 circuit diagrams given cover practically all of the apparatus used in a modern power or super-power electric station. The diagrams are of all degrees of complexity, beginning with the simple manually controlled starting rheostat and going on to the automatic substation. To the practical engineer they will be helpful. We hope that in the second edition of this book the author will be able to adopt international diagrams, and that he will also include diagrams for radio communication circuits.

Psychological Tests of Mental Abilities. By Prof. A. S. Woodburne. Pp. v+232. (Madras: Government Press, 1924) 2.8 rupees.

Although the method of mental testing is a comparative innovation in the field of education, its use is already almost ubiquitous. Most people know that it is widely employed in Europe and America, but perhaps fewer realise that its use has spread to Japan, China, Turkey, and, as the book under notice shows, to India.

Prof. Woodburne was invited last year to give a course of lectures on intelligence tests at the University of Madras, and he has extended his remarks to form a book. The larger part of it is a lucid description of the general principles of testing, and it shows evidence of wide reading and careful discrimination. Ample illustrations are given of the various types of linguistic, performance and vocational tests.

Some good work has already been done in India along these lines, and it is interesting to read of the necessary adaptations of standard tests in order to make them suitable for that country. Particularly illuminating also are the investigations of Prof. Haylands and of the author for the purpose of comparing the mental processes of the Indian and English adolescent. Indian educationists are keeping well to the fore in mental testing, for they have already planned a central clearing-house for results, and have suggested adequate instruction in testing methods for all their training college students.

In an Unknown Land. By Thomas Gann. Pp. 263+32 plates (London: Duckworth and Co., 1924) 21s. net.

The unknown land of which Mr Gann writes is Yucatan, which he visited with Dr S G. Morley for the purposes of archæological investigation. From Belize the party went northward and then westward on a two months' trip round the coast, making several inland expeditions to visit ruined Maya cities. Incidentally the book contains a great deal of information on a part of Central America that is little known and not easy of access, but its main value is the account the author gives of the Maya ruins and the Santa Cruz Indians. These form an independent tribe, since the Mexican government virtually evacuated their province, and represent the purest descendants of the Mayas. A great deal of work was accomplished, including visits to Chacmool, a previously unknown ruined city, Tuluum, which has always been difficult to reach owing to Indian hostility, and two minor new discoveries at Cancuen and Playa Carmen. All these are fully described. Of great interest are the accounts of the remarkable mural paintings of human figures and gods executed in bright colours on a hard stucco, found at Tuluum in a fresh condition despite their age of four centuries. The elucidation of the Maya method of dating in Yucatan was another striking discovery.

Graphic Statistics in Management. By W. H. Smith. Pp. vii+360. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 20s. net.

The recording of business activity by graphical means is extending rapidly among the controllers of large businesses, and a book like the present volume, written primarily in the atmosphere of American big business, should be of especial interest in Great Britain. The whole subject is treated in picturesque graphical fashion; no mathematical symbol appears anywhere, and yet a considerable degree of analysis of financial and business activity, production, sales, markets, and costing is successfully effected. The chapter dealing with graphical statistics in advertising is capital, a large number of illustrations of varying character being shown, including one demonstrating the effect of advertisement on church attendance and Sunday morning offerings!

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Biographical Byways: Dr. S. P. Langley.

I REGRETTED to see Sir Arthur Schuster's article in NATURE of February 7 presented so unpleasing a picture of my old chief, Dr. S. P Langley. Like some other great men I have met, his character had blemishes, and, as one of Sir Arthur's anecdotes indicates, it was surprising to see in so great a man such care to preserve the appearance of dignity which he thought properly attached to his office and his attainments If he had been as careless of it as Lord Kelvin, dignity would have wrapped itself about him like a cloak, crowned with the mantle of lovableness, which, to his intimates, Langley surely possessed. One is reminded of the Scripture saying: "He that loveth his life shall lose it"

In regard to the eclipse of July 29, 1878, Sir Arthur Schuster's recollection is contradicted by Langley's own account Prof Cleveland Abbe, indeed, was carried down on account of sickness, but Langley, though at first ill, remained at the summit of Pike's Peak, observed the eclipse, sketched the corona to 12 diameters, and his report and sketch is to be found in the publications of the U S Naval Observatory (Washington Observations, 1876, Pt. 2, vol. 23, pp 203-10).

As a pioneer, Langley has to his credit the great forward step that he took in the spectral study of the energy of radiation of the sun, the moon, and terrestrially heated bodies. He was the founder of modern methods in this branch of science Also, he lent his prestige to rescue from the domain of ridicule the subject of mechanical flight, and investigated at great length, with novel devices, the reactions of moving surfaces in the air On the basis of these experiments he accomplished prolonged steady flight of quarter-sized engine-driven mechanical models, about eight years before the first human flying with power-driven aeroplanes took place. Except for bad judgment in shooting his larger machine from a house-boat, instead of allowing it to take off gradually as was proposed, engine-propelled human flight would have been made several years before it actually occurred. The blemishes of such a man ought not to blind us to his greatness.

I am happy, however, to be able to soften the implication of the final anecdote of Sir Arthur Schuster. He got the quotation, I suppose, through several mouths, and it is not accurate. When I was about to start on my first expedition to Mount Wilson, in the year 1905, Dr. Langley came to my office to talk over the plans. Months earlier we had discussed his value of 3 calories for the solar constant, and he was nearly convinced, I believe, that it had been based on an error of logic in the reduction of the Mount Whitney observations. Yet he did not desire to publish a retraction, for, as he said, "Mr. Abbot, I did that work when I was at the height of my powers. Now that I have been long out of the field, I am not more competent than I was then to reason upon it." He paused a moment, and added with a twinkle in his eye: "As the witty Frenchman has said, 'What has posterity done for us that we should care so much for the opinion of posterity?'"

So, when we finished our interview in April 1905, it was rather in the nature of good-natured chaffing than in the nature of an order when Langley said to me. "You will, of course, bear in mind that it is rather the *variation* of the sun that you are going to measure than the absolute value of the solar constant." The twinkle came again into his eye, as he continued: "In fact, Mr. Abbot, I might add that for me the best value of the solar constant is that which nearest approaches 3 calories!" and, as he always did when he had said a good thing, he turned quickly and almost ran away. It was the last time that I saw Dr. Langley alive.

C G ABBOT.

Smithsonian Institution,
Washington, U.S.A.,
March 3.

Passivity of Iron and other Metals.

IT is well known that the principal metals which show the phenomena of passivity are chromium, manganese, iron, cobalt and nickel. These elements have this in common that they form divalent ions, and that while possessing electrons, *on* Bohr's theory, in the 4th-quantum orbit, their 3rd-quantum orbits are incomplete. My view is that these elements when in the active state have each two electrons in the 4th-quantum orbit, and that they become passive when one of these electrons is removed to a 3rd-quantum orbit. This implies that the usual chemical and physical agencies which make an active metal passive or a passive one active, merely, in some way, induce these electronic changes. It is for the physicists to say if this be possible. There is, however, no *a priori* objection to this view since transitions between 3rd- and 4th-quantum orbits of these elements are known to occur readily I do not suppose a suggestion of this kind will explain the whole of the phenomena of passivity, which is admittedly complex, but I offer it as a contribution towards the explanation of the more obvious phenomena.

Very few determinations of the electrode potentials of metals in the passive state have been published, and some workers have doubted if such determinations have any significance. I have found a simple way of preparing and keeping metals permanently in the passive state, and of comparing their electrode potentials with those of metals which do not show passivity. This consists in obtaining metals two at a time in mercury and comparing their powers of reducing solutions in sulphuric acid of uranyl sulphate, ferric sulphate, potassium permanganate and other oxidising agents. I find the order of the potentials of the metals in mercury is (proceeding from electro-positive to noble metals and including only those relevant to this discussion): zinc, cadmium, thallium, tin, lead, copper, manganese and iron, bismuth, cobalt, mercury, nickel and platinum. The order of these metals seems quite definite. It is the same whatever oxidising agent be reduced, whether the solutions be hot or cold, whether sulphuric or hydrochloric acid be employed, and whatever other metals are present in the amalgam. The order of potentials of metals in the free state is known to be: manganese, zinc, iron, cadmium, thallium, cobalt, nickel, tin, lead, copper, bismuth, mercury and platinum. A comparison of these two lists shows that only the metals known to show passivity fall out of order. The simplest inference is that the passive state is a quite definite condition, and that it is produced and maintained when the metal is amalgamated. This is consistent with Lambert's discovery that pure iron is a noble metal when its surface is electrically neutral.

The ions of these passive metals, however, do not behave as if they were the ions of noble metals. For example, ions of tin, lead and copper, but not of

cobalt, iron or nickel, are easily reduced to the metallic state by zinc amalgam in sulphuric acid solution. The order of the ions is probably similar to that of the metals when their electrode potentials are determined in the free state If this be so, it follows that elements which show passivity must have alternative configurations of planetary electrons, one of which corresponds to the configuration possessed by its ion. On present knowledge the number of electrons in the atom of iron is 2, 8, 14, 2 in the 1st-, 2nd-, 3rd-, and 4th-quantum orbits respectively, and in the ferrous ion 2, 8, 14, 0. If the latter configuration represents the ferrous ion, the former should represent the active iron because active iron passes readily into the ferrous condition Passive iron may therefore have one of the configurations 2, 8, 15, 1; 2, 8, 13, 3. Similar considerations apply to the metals chromium, manganese, cobalt and nickel When each of these elements has two electrons in the 4th-quantum orbit, it is likely to be in the active state and, when another number of electrons, it is likely to be passive

I think that this number is probably one because (*a*) it cannot be less, and (*b*) the agencies that are known to bring about passivity might possibly force one of the 4th-quantum electrons into a 3rd-quantum orbit This view receives some support from the following nickel is normally passive, that is, it differs from the other elements which show passivity in being rendered passive more easily than active. Now, according to Kramers and Holst, the configuration of the electrons in nickel is likely to be 2, 8, 17, 1. This on the views expressed here would represent the passive metal, and the alternative configuration 2, 8, 16, 2, from which the nickel ion is derived, would represent the active

I might add that metals when dissolved in mercury are far more efficient reducers in the presence of sulphuric acid than when in the free state. For example, tin, lead and iron are nearly one hundred per cent efficient when reducing ferric sulphate in sulphuric acid of different strengths, that is to say, these metals go into solution only in so far as it is necessary to bring about the quantitative reduction.

A. S. RUSSELL

Dr Lee's Laboratory,
Christ Church, Oxford,
February 21

The Compton and Duane Effects.

THE experimental arrangement used by Compton has been such as to emphasise the fact that the change of wave-length represented by the most intense part of the modified line agrees with the formula

$$\lambda_\phi - \lambda_0 = h \text{ vers } \phi/mc, \quad . \quad . \quad . \quad (1)$$

where λ_ϕ is the wave-length of the X-rays scattered at an angle ϕ and λ_0 is the wave-length of the primary rays On the other hand, the experimental arrangement used by Duane has until recently been such as to emphasise the fact that very often the modified rays consist of a band of wave-lengths beginning at a wave-length change given by

$$\lambda_\phi - \lambda_0 = \lambda_0^2/(\lambda_s - \lambda_0), \quad . \quad . \quad . \quad (2)$$

where λ_s is a critical absorption wave-length of the scatterer More recently Allison and Duane (*Phys. Rev.*, 25, 235, 1925) by using smaller scattering blocks have found an agreement with (1), although they remark that there is a band of wave-lengths about this value This band nature of the wave-length change is also evident in Compton's curves (*Phys. Rev*, 22, 409, 1923). Some of the width of the band is due to the variation of ϕ in (1), but when the width due to this cause is subtracted from the width shown in Compton's curves, there is still some excess width. The writer has been able to explain this excess width by taking into account the momentum of the scattering electrons in their Bohr orbits (*Phil. Mag.*, in print) The electrons are moving in all sorts of directions, and hence we get a wave-length change varying from a minimum to a maximum, the width depending on the magnitude of the momentum of the electrons.

More recently, the writer (*Phys. Rev.*, in print) has been able to show that, if the binding energy is above a certain amount, and therefore the momentum of the scattering electrons above a certain other amount, the width given by taking into account the momentum of the scattering electrons alone is such that the minimum change of wave-length is less than that given by (2) However, the least possible change of wave-length is given by (2), because the recoil electron must be given sufficient energy to overcome its binding energy to the atom in order to be ejected. If the energy given to the electron by the scattering process is less than this, then the electron cannot be ejected from its Bohr orbit, and we may suppose that the mass of the rest of the atom is added to that of the electron. This causes m in (1) to be large, with the result that the change of wave-length is negligible.

Hence we have a quantum theory explanation of the existence of the unmodified line. Whenever there is an unmodified line produced by the scattering of X-rays by electrons of a certain type (*K*, *L*, etc.), then the wave-length change of the beginning of the modified band is given by (2) For example, when Mo$K\alpha$ X-rays are scattered at 90° by the *K* electrons of carbon, the modified band begins at a wave-length change of 0·012 Å U and extends to 0·057 Å.U The short wave-length limit of the modified band is in this case independent of the angle of scattering, which is in agreement with Duane's earlier experiments. The long wave-length limit, however, depends upon the angle of scattering Duane in these earlier experiments used a large scattering block, so that there was considerable variation of the scattering angle ϕ This variation of ϕ causes a variation in the long wave-length limit of the modified band, but not in the short wave-length limit. The theory indicates that with a given value of ϕ the intensity is approximately the same all over the modified band Hence with a large variation of ϕ the intensity would be greatest at the short wave-length limit of the band. This is the result observed by Duane.

The above is an explanation of Duane's results with a large scattering block. Compton, however, finds for $\phi = 90°$ that the wave-length change of the most intense part of the modified band is 0·0242 Å.U. Compton used a smaller scattering block and a spectrometer of less resolving power than Duane. With a small scatterer, the modified band would still extend from $\lambda_\phi - \lambda_0 = 0{\cdot}012$ to $\lambda_\phi - \lambda_0 = 0{\cdot}057$ Å.U. for the scattering of Mo$K\alpha$ X-rays by the *K* electrons of carbon. However, there are also *L* electrons in carbon. Of these the *L III* electrons move in circular orbits, and these *L III* electrons produce a modified band extending from $\lambda_\phi - \lambda_0 = 0{\cdot}0185$ Å.U. to $\lambda_\phi - \lambda_0 = 0{\cdot}030$ Å.U. The band does not in this case extend from the value of $\lambda_\phi - \lambda_0$ given by (2), and hence there are no unmodified rays scattered by the *L III* electrons at 90°. The centre of the modified band is seen to be at 0·0242 Å.U., the value given by (1) The *L III* band will be superposed on the *K* band; but the former will stand out more strongly since the theory indicates that the intensity (*i.e.* the energy per unit wave-length width) of the *L III* band is greater than that of the *K* band.

Hence, when a small scatterer is used the modified band shows great intensity at 0·0242 Å.U. The centre of this intense portion and its width depend, however, on ϕ. Hence for a large scatterer the intense portion becomes indistinct. Further, for a large variation of ϕ, the theory shows that the most intense part of the band due to the *L III* electrons is displaced to the short wave-length side of the value obtained by putting the average value of ϕ in (1). Large scatterers, therefore, tend to obscure the existence of the Compton wave-length change.

Still further, a spectrometer of low resolving power will show the Compton wave-length change better than one of high resolving power. With low resolving power the most intense part of the band comes at 0·0242 Å U. for $\phi = 90°$, whereas with high resolving power the band character of the modified rays is emphasised. For example, with high resolving power the $K\alpha_1$ and $K\alpha_2$ lines of molybdenum can be separated in the unmodified line, while the modified band will show no such separation, as each modified band overlaps the other due to its width. The absence of separation in the modified band might cause an experimenter using high resolving power to doubt the existence of the Compton effect

G. E. M. JAUNCEY.

Washington University,
St Louis, U.S.A.,
February 14.

Transmission of Stimuli in Plants.

NATURE of January 17 has just reached me and I hasten to send a reply to Mr Snow's letter on this subject I repeat once more that in the numerous experiments which I carried out with the stem of *Mimosa pudica*, the stimulus was never transmitted across the water gap. Mr. Snow repudiates the idea that he has disagreed with my conclusions in regard to the conduction in the petiole of Mimosa. "Actually, however," he says in his letter, "in agreement with him [Sir J. C. Bose] I have produced evidence to show that in the leaf, excitation is conducted in the phloem and has nothing to do with the transpiration current. I agree also that this conduction in the leaf is, in all probability, a true physiological process, and consider that Sir J. C. Bose's experiments on the petiole, which so strongly support this view, are of very great value. In the stem, however, as I found, this conduction in the phloem either fails completely, or at least is regularly too weak to cause the leaves to fall."

Since it is admitted that conduction does not take place across a water gap in the petiole, Mr. Snow will note that there is a serious breach of continuity in the assumption that the mechanism of conduction in the stem is widely different from that in the petiole. We stimulate the leaf; excitation is transmitted along the phloem in the petiole and overflows into the stem, causing the successive fall of the leaves. Where does the hiatus in the conducting mechanism come in? The supposed conduction across a water gap in the stem has led to the theory that the transpiration current in the wood is the means of conduction of excitation. But the observation of Mr. Snow himself does not support this theory, for he finds, in opposition to Prof. Dixon, that Dr. Ricca's theory of the transpiration current is inadequate "to cover *all* the phenomena of conduction in Mimosa, including conduction in the leaf and the subordinate phenomenon of 'high-speed' conduction in the stem."

In my "Physiology of the Ascent of Sap" (1923), p. 269, I have clearly explained the modes of intercommunication and interaction between more or less distant organs of a plant. "This is accomplished in two different ways, by *transfer of matter* and by *transmission of motion*. The first is exemplified by hydraulic convection of liquids carrying chemical substances in solution, such as occurs in the circulation of sap; the second, in the conduction of excitatory change along nerves." These two can be easily distinguished from each other from the fact that the conduction of excitation is from a hundred to a thousand times quicker than the sap-movement of the transpiration current. A very simple experiment which requires no apparatus is to put a drop of hydrochloric acid on the tip of a leaf of *Mimosa pudica*: the acid remains practically localised, but the protoplasmic excitation induced by it is transmitted with considerable velocity, causing the fall of numerous leaves both above and below. This experiment, which can be repeated without any difficulty, completely demolishes the theory of the transpiration current.

I have, as stated in my previous letter, carried out numerous crucial experiments which fully establish the nervous character of the transmitted impulse in Mimosa. It has been a matter of surprise to me that reference to my work has been omitted in all letters and articles on transmission of stimulus in Mimosa that have appeared in NATURE during the last year This could not have been due to the obscurity of the journal in which my results appeared, for they were published in the Proceedings and Transactions of the Royal Society. The omission appears to me to be very curious; it cannot but obscure truth and thus divert the energy of workers in wrong directions which lead nowhere.

In this short communication I can make but bare mention of only a few of the results which I have recently obtained. The anatomical structure of the nervous tissue, made clear by selective staining of microscopic sections, has been found to be in every way the same in the petiole and in the stem. The distribution of the nervous tissue in the whole plant has been clearly traced, affording the fullest explanation of the transmission of excitatory impulse up and down and across the stem. The innervation of the contractile pulvinus, which functions as a muscle, has also been fully investigated, making possible a rational explanation of the purposeful movements by which the leaf places itself so as to absorb the largest amount of radiant energy. Still more striking is the success of my efforts to obtain, by means of selective staining, a definite outline of the rapidly contracting tissue in the pulvinus of *Mimosa pudica* No such staining occurs in the slowly reacting pulvini of other plants. This characteristic denotes the possession of a specific catabolic substance, and is highly significant These and other results prove that a very high and quite unexpected degree of differentiation has been reached in the nervous system of Mimosa I am in hopes of early publication of these results. In case of unforeseen delay, I shall take the opportunity of sending a short account of them for publication in NATURE.

J. C. BOSE.

Bose Institute, Calcutta,
February 12.

The Behaviour of Crystals and Lenses of Fats on the Surface of Water.

DURING the last two years we have been interested in examining the behaviour of crystals and liquid lenses of fatty acids and esters when placed upon the surface of water.

Sir W. B. Hardy was the first to observe that the magnitudes of the surface tensions of the various

bounding interfaces for liquids, such as oleic acid, which spreads upon water, were in accordance with the theorem of Dupré,

$$\sigma_{H_2O} > \sigma_{Oil} + \sigma_{Oil\ water}$$

A lens of oleic acid, when placed upon a water surface of limited area, does not extend as a thin lamina of oil in bulk, but as a unimolecular film, by a process of two-dimensional solution or evaporation from the edges of the lens Equilibrium between lens and unimolecular oil film is finally attained when the rate of this process of surface solution or evaporation is balanced by the reverse process of condensation of oil molecules from the film The surface pressure of the film when equilibrium is established is defined by the equation—

$$\sigma_{\text{Contaminated surface}} = \sigma_{Oil} + \sigma_{Oil\ water}$$

We have noted that solid fatty acids and esters will spread on water surfaces until the surface tension of the water falls to a definite equilibrium value, but the rate of spread is much slower than for liquids

The beautiful experiments of Mr Adam have revealed the interesting fact that surface films may exist in two forms, the condensed and the expanded, the former being the two-dimensional prototype of solids and liquids, the latter of vapour Both crystals and liquid lenses can exist in equilibrium with both these condensed and expanded films, the equilibrium pressures being naturally different for each phase, and varying in a marked manner with the temperature, similar to the three-dimensional phase properties of solubility and vapour pressure

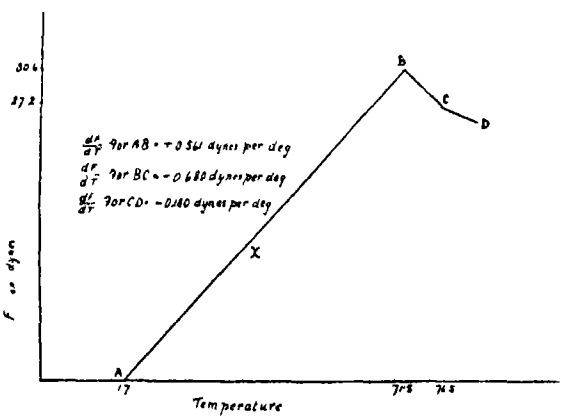


FIG 1

Fig 1 represents a typical F T. curve for stearic acid, in which this equilibrium two-dimensional pressure in dynes per cm is plotted as a function of the temperature

Along the line AB the film in equilibrium with the solid crystal is condensed, the superficial melting-point of the film being at x. At B the crystal melts, and the curve BC represents the variation with the temperature of the condensed film in equilibrium with a lens of the liquid acid At the third non-variant point C the condensed film expands, and the curve CD represents the temperature variation of the two-dimensional expanded film in equilibrium with the liquid lens

As in the case of three-dimensional phase equilibria, it is possible to calculate the various latent heats associated with the changes of the bulk solid and liquid into the two-dimensional condensed and expanded modifications. We may apply a modified equation of the type suggested by Clapeyron,

$$\frac{dF}{dT} = \frac{L}{T(A_2 - A_1)},$$

where A_2 is the area of the film, A_1 the area of the acid in bulk, T the temperature, and L the latent heat of the change in question. From the curve AB we obtain 5860 calories as the latent heat of transformation of the acid from the bulk solid to the condensed film, at the point B From BC we obtain −6840 calories as the latent heat of change of the bulk liquid into the condensed film at the point B. From these two values we obtain 12,700 calories as the latent heat of fusion of stearic acid, a value in reasonably good agreement with 13,500 cited in Landolt Bornstein

In a similar manner, the other latent heats of transformation may readily be calculated, although the actual area of the molecules in the expanded state cannot be computed so accurately as for condensed films

Through the kindness of Mr N. K Adam and Dr. Garner a number of organic acids and esters in a highly purified state have been placed at our disposal, and we have succeeded in obtaining a number of these F T curves and in making similar calculations from the data so obtained We hope to publish these data *in extenso* in the near future, as soon as certain corrections necessitated by the use of the ring method have been accurately determined

A P CARY,
ERIC K RIDEAL.

Laboratory of Physical Chemistry,
Cambridge, March 6

Ectodermal Muscles in a Crustacean.

THE generally accepted view as to the origin of the musculature of the Crustacea is that it is derived from the mesoderm In Chirocephalus, while the majority of the muscles arise from the mesoderm, there are others that are definitely of ectodermal origin The dilator muscles of the proctodæum are examples of this type, and probably with these should be classed the dilator muscles of the œsophagus. At the most posterior tip of the body, where the ectoderm folds inwards to form the proctodæal tube, the formation of the dilator muscles can be seen most clearly. Certain ectodermal cells in this region elongate and then, while retaining one end in the outer ectoderm, the other passes inwards with the invaginating ectoderm This passage inwards is probably not an active migration, but is brought about by the proliferation of the surrounding cells, the latter pushing in between the two ends of the muscle cell. In the elongating cell body one or two fibrils appear that very early divide into segments, giving the typical structure of striped muscle. The final muscle is thus an elongated cell, attached at its inner end directly to the cuticle lining the proctodæum and at the other end to the external cuticle.

A more interesting set of ectodermal muscles is to be found in the trunk region. In this region the limbs appear at first as a series of pouch-like outgrowths and, as a result of this development, the ectoderm in between them forms a series of ventro-lateral ridges projecting into the body cavity. As the limb rudiments enlarge, the inner edges of these ridges become nipped off from the more lateral ectoderm. In this way a string of cells is formed on either side in each intersegmental plane, running from the mid-ventral line to the dorso-lateral ectoderm. Deeply staining fibrils appear in them

almost at once. These spread out dorsally into a fan and, running between the nuclei of the superficial ectodermal cells, end directly against the cuticle Ventrally they terminate in a narrow bundle against the cuticle of the mid-ventral line For a considerable time no change other than growth takes place, but ultimately, at the dorsal end, at the level of the inner face of the surrounding ectoderm cells, the fibrils lose their staining capacity and become replaced by a tendinous plate Below this plate the fibrils now divide into segments converting the strings of cells into typical striped muscles Above it they persist as a radiating series of "tendo-fibrils," showing no signs of segmentation and ending directly against the cuticle

On the outer side of this series is another set of muscles having the same median ventral attachment, but having an upper attachment just below—that is, more lateral to that of the first series. These are also entirely ectodermal in origin, and are formed in the same way as the first series

The important facts that emerge from this development are, first, that certain muscles of the Crustacea are definitely ectodermal in origin, a fact not at all in conflict with what might be deduced from the ancestry of the group; and, secondly, that the "tendo-fibrils" that run from the cuticle through the ectoderm cells to attach to endoskeletal structures may be the remains of the same originally continuous fibrils that divide up elsewhere to give the myofibrils of typical striped muscle

H GRAHAM CANNON.

Zoology Department,
Imperial College of Science,
South Kensington, S.W.7

On the Absorption Spectrum of Aluminium.

It is well known that the study of the absorption spectrum of elements provides us with the simplest method of determining the normal states of atoms In the hands of Wood, Bevan, McLennan, and others, the study of the absorption spectrum corroborated that in the case of elements of the first and the second groups, the normal orbits are those designated spectroscopically as 1*s* and 1*S* respectively

In the case of elements of higher groups, the experiments become more difficult, as most of them have high boiling-points, so that with the furnaces which can be commanded in a physical laboratory, very little vapour can be obtained for absorption work This difficulty becomes more acute in the case of metals of the third group, all of which, excepting thallium, yield very little vapour up to temperatures of 1200° C.; and, in fact, we are not aware that any successful experiment has been done on the absorption spectrum of aluminium and boron, which are the least volatile elements of this group. At the same time, such experiments are necessary for determining once for all whether for these elements the $2p_1$ orbit is the normal stage, as has been obtained from the analysis of their arc spectra and corroborated by the absorption experiments in the case of indium, gallium, and thallium.

We have recently carried out successfully the absorption experiment with aluminium, using the vacuum furnace designed by Prof Meghnad Saha for ionisation work. The furnace consists of an Acheson graphite tube heated by a battery of accumulators. The temperature was simultaneously measured by a Wanner pyrometer. We used a cadmium spark, and a copper spark under water as our sources of continuous light. The spectrum was photographed on Ilford ordinary plates sensitised by nujol, as described by Lyman. We found that no aluminium lines are obtained below 1500° C. At 1520° C., the pair $\lambda = 3961, 3944$ come out reversed. At 1650° C., the leading members of $2p_t - md$ series come out reversed. The higher members of $2p_t - ms$ series require a little higher temperature Another curious feature is that on all plates the $2p_t - ms$ lines and $2p - md$ lines of gallium occur rather prominently Apparently gallium occurs as an impurity in ordinary samples of aluminium.

From such experiments it is not possible to deduce whether for aluminium the $2p$- orbits are the normal orbits, or whether there is a still larger 1*s* orbit For at the temperature at which sufficient vapour is available for absorption work, the thermal stimulus is quite sufficient to convert any lower 1*s* orbit to the $2p$-orbits The vapour pressure of aluminium is evidently very low even at 1520° C., but we could not find any existing data on the subject, except some theoretical considerations by Gruneisen. Our apparatus is suited to the determination of vapour pressure of aluminium over a large range of temperature by using the so-called *Mitfuhrungs-methode* of Pfaundler, and we hope to carry it out at an early date At any rate, it is quite clear that the $2p - mx$ lines require a lot of vapour for absorption, and if the $2p$- orbits turn out to be the normal orbits of aluminium atom, they do not dominate the spectrum to the same extent as the 1*s* orbits of alkalies dominate their spectra

KANAKENDU MAJUMDER
NALINE KANTA SWE

Physical Laboratory,
Allahabad University, India

The Origin of Sponge-spicules.

It is to be regretted that Dr Bidder (NATURE, February 28), before publishing his criticisms of my theory of the symbiotic origin of sponge-spicules, did not await the publication of the detailed evidence upon which that theory is based I am loth to enter into controversy with him, but as his letter contains much that is misleading, I feel that I can scarcely pass it over in silence He speaks of the observation (presumably mine) "that the first rudiment of the spicule in Stelletta is a skeleton-crystal on the tetrahedral system" I made no such observation On the contrary, I endeavoured to show by observations on the silica pearls that the first rudiment is a minute granule resembling a Micrococcus

Dr Bidder's "crystallographic explanation," so far as siliceous sponges are concerned, appears to rest on the assumption that the protorhabd, or axial thread, is itself composed of silica Otherwise it would be difficult to understand his "conjecture" as to the variation of the type of crystallisation with the percentage of water in the "spicopal." His supposed "skeleton-crystal" can be nothing but the radiating axial threads He admits that the silica afterwards deposited upon it is "in amorphous aggregation" Unfortunately, the best observers, such as Bütschli and Schulze, are in agreement that the axial thread is composed of a protein substance, and there is nothing else that could form the siliceous skeleton-crystal which he imagines to exist The statement that my scleroplastids "are at first gelatinous but become crystalline" is pure invention. It is well known that the axial thread, formed, as I believe, by elongation of the scleroplastid, retains its original "organic" character in the axial canal of the fully formed spicule, and, so far as I am aware, no one has hitherto ventured to suggest that it becomes crystalline.

Dr Bidder accuses me of having "strangely changed" the name of a certain sponge to Donatia. If he will study the literature of the subject he will

find that this is the name now generally given by spongologists to the genus in question, and for very good reasons I have merely followed precedent, and in any case I fail to see what the nomenclature of this genus has to do with the question at issue

What Dr Bidder means by saying that the Suberitidæ have triaxon spicules I do not know I can only say that Suberites has not In his reference to the "innumerable 'species' of sponges which infest our books," he seems anxious to belittle the work of "classifiers," but if he would pay more attention to this work he might perhaps come to realise that it has plainly demonstrated that sponge-spicules, like other organic products, have a long evolutionary history behind them, that they can be arranged in evolutionary series, and that in their individual development they may actually recapitulate their ancestral history. It is perfectly useless for any one to attempt to discuss this subject merely on the basis of acquaintance with a few of the simpler spicule forms.

ARTHUR DENDY

King's College, Strand, London,
March 3

The Action of Silica on Electrolytes.

THE questions raised in Prof Mukherjee's letter of January 31 are so important that I should like to reply briefly

(1) I have not found any reason to depart from the views expressed in our paper in the Transactions of the Chemical Society (T. 1923, 123, 2027) that pure silica does not exhibit any absorbing or reacting power towards acids I have made experiments with commercial "silica gel" and N/500 hydrochloric acid, and at first obtained an indication of absorption, but soon found that this was due to some impurity, as the specific resistance of distilled water was lowered from 500,000 to 35,000 ohms on addition of the gel. It was therefore purified by washing once with hydrochloric acid and then repeatedly with water until the specific resistance rose to 350,000 ohms, and finally dried and heated to 180° After this treatment, no absorption of acid could be observed, the P_H of the acid being the same (2 69) before and after the addition of 10 per cent of the gel An experiment with oxalic acid, using gel which had been purified with nitric acid, also gave a negative result.

(2) It is not clear how previous treatment with acid can destroy any absorbing properties that silica possesses, and I presume that Prof Mukherjee's hydrated substance comes in contact with acid at some stage of its preparation. However, to make sure, the gel purified with hydrochloric acid was fused with sodium carbonate and the residue tested with silver nitrate, no chloride could be detected

(3) I do not quite see Prof Mukherjee's difficulty in understanding the experiment in which we found that, whilst pure silica reduced the P_H of sodium chloride solution to 3 96, the impure silica (which contained alkali) only did so to 5·55 The concentration of the silica suspension used was 20 grams per litre, and it seems quite reasonable that 20 grams of an impure alkaline material should neutralise 10^{-4} grams of hydrogen-ions

(4) In this connexion I may point out that the hydrogen-ion concentration of a weak acid solution (*e.g* N/5000 hydrochloric acid) falls to about half its calculated value when left for a few minutes in an ordinary glass vessel. No change is observed if the vessel is coated internally with paraffin wax or is made of silica. Filter papers also must be used with caution, as all those tried change the specific resistance and P_H of distilled water.

This problem is of great interest to us, and if Prof. Mukherjee could at any time spare a small quantity of his pure hydrated silica, we should very much like to make experiments with it A. F. JOSEPH.

Wellcome Tropical Research Laboratories,
Khartoum, February 21.

The Reported Anti-Relativity Experiment.

UNFORTUNATELY, owing to travelling delays, a modified proof of my response to an editorial inquiry (appearing in NATURE of March 21, p 433, col 1) did not reach the printers in time The experiment reported as having been attempted by Prof Michelson and Dr Silberstein can scarcely have been conducted in water, though water-pipes were used It may probably be conveniently regarded as a large-scale reproduction of an experiment by an Italian professor who inverted my whirling disk experiment on ether (Phil. Trans., 1893) by mounting the whole of the apparatus on a turn-table, including source of light and receiving camera, and looking for a shift of interference bands photographically In the experiment now reported the turn-table was apparently replaced by the earth I suggested such an experiment on p 151, vol 189, of the Phil Trans for 1897 If, as is probable, a positive effect can ultimately be securely demonstrated, it will be for relativists to say whether their position is at all affected, or whether the loop-hole—that rotation is exceptional, because in rotation matter is moving oppositely on opposite sides of the axis—is acceptable

It may be convenient to reproduce the passage from Phil Trans., 1897, referred to above

"It is to be observed that since a motion of the disks relatively to the observer and the light causes no effect, the ether being stationary, it follows that a motion of the light and observer would produce an effect, since they would be moving relatively to the ether. Hence if, instead of spinning only the disks, the whole apparatus, lantern, optical frame, telescope, observer and all were mounted on a turn-table and caused to rotate, a reversible shift of the bands should be seen . . My present optical apparatus mounted on a turn-table revolving 4 times a minute should show something, viz., $\frac{1}{10}$th band shift each way . . . If the ether is stationary near the earth, that is, if it be neither carried round nor along by that body, then a single interference square, 1 kilometre in the side, would show a shift of rather more than one band width, due to the earth's rotation in these latitudes (see p 772, Phil. Trans., 1893)

"But as the effect depends on the area of the square, a size of frame capable of mechanical inversion is altogether too small, there may, however, be some indirect ingenious way of virtually accomplishing a reversal of rotation—something, for instance, based on an interchange of source and eye—and if so, it would constitute the easiest plan of examining into the question of terrestrial ether drift"

OLIVER LODGE.

The Glow of Phosphorus.

THE process of the slow luminous oxidation of phosphorus presents anomalies which are still incompletely understood. Thus, the non-occurrence of a glow in pure oxygen until the pressure is reduced to about 500 mm. of mercury, or an equivalent dilution with an inert gas is made, is very striking. No less difficult to explain is the ability of traces of certain vapours to inhibit the luminosity. These

features are also exhibited in the slow oxidation of phosphorus trioxide, and it has been suggested that the phenomena of the glow of phosphorus are due to the trioxide formed in a preliminary non-luminous oxidation. Again, phosphine does not react with oxygen at ordinary pressures, but on reducing the pressure an explosion occurs.

With the view of elucidating these difficulties the nature of the light emitted in these oxidations is being studied spectroscopically. It was recently shown (Emeléus and Downey, J.C.S. Trans. 125, 2491, 1924) that the light from glowing phosphorus, and that from the element burning normally, give the same spectrum. This is continuous in the visible region, and has five bands in the ultra-violet between $\lambda = 2370$ Å.U. and $\lambda = 3290$ Å.U. These observations have now been extended with the following results: the light from glowing phosphorus trioxide, and from spontaneously inflammable phosphine burning in oxygen, give this same spectrum. In the first case the strongest three of the five ultra-violet bands have already been identified. There is little doubt that the remaining bands will be shown on lengthening the exposure. In the second case all five bands have been observed, in addition to bands generally attributed to water at about $\lambda = 3060$ Å.U. and $\lambda = 2800$ Å.U.

The fact that the light from glowing phosphorus and that from phosphorus trioxide both give the same spectrum supports the analogy between these two oxidations, already well established in other respects. These observations, however, cannot be taken as proof of the identity of the chemical processes. They indicate rather that there is some radiating system involved in them all, which gives rise to a definite band spectrum. Such a system may well have a connexion with the chemical anomalies common to the low temperature oxidation of these phosphorus compounds.

H. J. EMELÉUS.

Chemistry Department,
Imperial College of Science and Technology,
London, S.W.7, March 4.

The Structure of the Mercury Line 2536.

AN investigation of the fine structure of the 2536 line of mercury has just been completed as a preliminary to the continuation of the work on the controlled orbital transfers of electrons in optically excited mercury vapour described recently in the Proceedings of the Royal Society. It has been found that the structure photographed by Prof. Nagaoka is not the true structure at all, but an absorption spectrum, or perhaps more exactly a structure caused by the self reversal of the true components, resulting from the circumstance that he worked with an Arons-Lummer type of lamp, in which the light of the arc is obliged to pass out through a column of non-luminous mercury vapour, before entering the interference spectroscope.

The true structure has been observed with a water-cooled vertical quartz mercury arc, the discharge being pressed against the wall of the tube adjacent to the spectroscopic train by a very weak magnetic field. There are five components of uniform intensity, four at sensibly equal intervals, the fifth having a slightly greater separation. The observations were made by two quartz Lummer-Gehrke plates crossed in the usual manner. On passing the light through a cell 1 cm. in thickness containing mercury vapour in vacuo at room temperature, each one of the interference points doubles by reversal and we have a row of ten dots. On increasing the thickness of the absorbing layer some of these coalesce, and we end up with a structure sensibly the same as that described and figured by Nagaoka: I say "sensibly" as there appears to be a slight difference between the absorption of mercury vapour in a separate cell, and that of the vapour in the neck of the Arons lamp, which is in a state of ionisation from its contact with the arc. The effect of magnetic fields on the components has also been studied.

R. W. WOOD.

Johns Hopkins University, Baltimore.

Les rayons γ de haute énergie et leur effet photoélectrique.

DANS une lettre récente à la NATURE (Feb. 14, p. 226) Mr. D. H. Black attire l'attention sur un rayon γ du thorium B d'énergie élevée. Son interprétation dans le spectre naturel indique sa conversion en rayon β par son action sur les niveaux *K* et *L* d'un élément de nombre atomique 82 ou 83.

Ces faits sont à rapprocher de ceux que M. Jean Thibaud a signalés il y a quelque temps (*Comptes rendus*, tome 178, 1924, p. 1706; tome 179, 1924, pp. 165, 815, 1052, 1322). M. Thibaud travaillant dans mon laboratoire a pu obtenir les spectres excités photoélectriquement par des rayons γ dans les éléments les plus divers; il a montré qu'on observait la conversion de rayons γ de près de deux millions de volts sur les niveaux *K* et *L* d'atomes lourds (uranium, plomb, platine, tungstène). En particulier un rayon γ de 1,775,000 volts, émis par le radium C, se convertit sur des niveaux *L*, d'énergie *140 fois moindre*.

L'effet photoélectrique des rayons γ de haute énergie se produit avec une intensité remarquable sur les niveaux *K* d'éléments plus légers, tels que le cerium, l'antimoine, l'étain, l'argent et même le cuivre et le fer.

M. Jean Thibaud a vérifié très exactement, en étudiant le déplacement des diverses raies photoélectriques lorsque l'on fait varier le nombre atomique du "radiateur" secondaire, que la relation quantique d'Einstein était aussi bien valable pour les quanta très élevés que pour les plus faibles. Il a montré enfin l'identité des spectres β naturels et des spectres β excités pour Ra B+C, Th B+C+C″, Ms Th 2 et confirmé ainsi l'origine secondaire des spectres naturels de ces éléments.

M. DE BROGLIE.

Laboratoire de Recherches Physiques
sur les Rayons X,
29, rue Chateaubriand, Paris, 8e.

Radio Reception on Frame Aerials.

I WAS much interested in Mr. Cowper's letter in NATURE of February 21 on radio reception on frame aerials. For some time I have been quite sure that the usual estimates of probable signal strengths are much too low.

On a four-valve (1 H.F. Det. 2 L.F.) it is possible, on a roughly constructed frame 16 inches square, of 30 D.C.C., to receive all B.B.C. stations at loud-speaker strength. The tuning is very acute, and, as Mr. Cowper mentions, with special arrangements for reaction control. This was with B.T.H. B.5 (0·06) valves. I have never tried for American stations, but have no doubt they could be heard.

The station was on the south side of a sheltered valley and the apparatus about 6-8 ft. above the ground. The first station I ever heard was Manchester, so loudly that, until the announcer gave the name, I was quite sure it was either Plymouth, 25 miles, or Bournemouth, 90 miles, distant.

D. M. ELY.

The School House,
Kingsbridge, Devon.

The Rotor Ship and Aeronautics.

By Prof. L. BAIRSTOW, F.R.S.

THE conversion by Herr Anton Flettner of the sailing ship *Buckau* into a rotor ship was referred to in NATURE of November 22, p. 758, and brief reference was then made to the principles underlying the new proposal for ship propulsion. Since then, details of experiments in wind channels have appeared from which estimates may be made of the forces on rotating cylinders and the power needed to drive them.

Experiments at Göttingen, and the underlying theory, are described by Prof. L. Prandtl in *Die Naturwissenschaften* for February 6, whilst the same material is the basis of a small booklet, "Das Rotorschiff und seine physikalischen Grundlagen," by J. Ackeret.[1] Both these publications contain a bibliography, the earliest reference being to a paper by B. Robins in 1842 (London) Owing to the importance of his investigations, the effect on which the rotor ship depends is spoken of as the "Magnus effect," and is described in a paper published in 1852 in connexion with artillery investigations. Lord Rayleigh's paper of 1877 "on the irregular flight of a tennis ball" deals with the same mathematical theory. Tests for the American National Advisory Committee for Aeronautics have been made and the results published in Technical Note No. 209, a very full abstract of which appears in the issue of *Flight* for January 8, 1925.

The analysis underlying the use of rotating cylinders for rotor ships is the classical hydrodynamical theory to be found in standard treatises.[2] In the application, certain approximations are made and there is some lack of agreement between calculation and observation corresponding with them. The most important assumption is that which supposes the effects of viscosity in a real fluid to be confined to a thin layer on the surface of the cylinder and that, outside this boundary layer, air behaves as an inviscid fluid. The general theory of the boundary layer as given by Prandtl shows it to be thinner and thinner as the speed and size increase and as the viscosity decreases. The exact criterion is a "Reynold's number." For a non-rotating cylinder this "Reynold's" number is Vr/ν, where V is the forward speed of the cylinder, r its radius, and ν the kinematic coefficient of viscosity. When the cylinder is rotating with a circumferential velocity U there will be a separate "Reynold's number" for each value of the ratio U/V.

Any one acquainted with the flow of air or water past bluff obstacles will be aware of the fact that eddies form in their wake and that there is a region of stagnant fluid which does not conform to the hypothesis that the boundary layer is thin, and in fact the classical hydrodynamics is wholly inapplicable to a non-rotary cylinder. The streamlines as calculated are shown in Fig. 1, and give a motion for which there is no force on the cylinder in any direction. The flow round a cylinder in a real fluid differs very greatly from that shown behind the section BB'.

Rotation of a cylinder in stationary fluid produces circulation. Viscosity is called into play to ensure the transmission of the motion of the cylinder to the fluid in contact with it, but in all other respects viscosity is ignored. The resulting streamlines are circles concentric with the cylinder, the velocity in them being inversely proportional to the distance from the centre of the circle.

By superposition on the well-known lines of Clerk

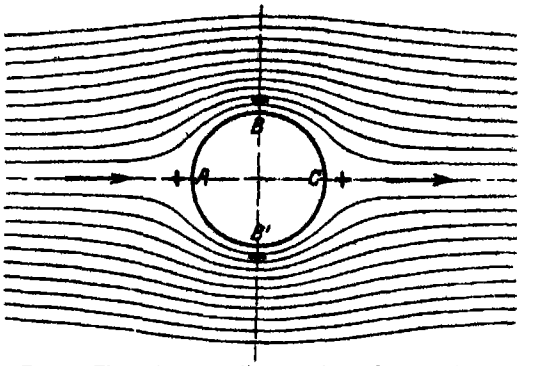


FIG. 1.—Theoretical streamlines round a stationary cylinder. Reproduced by courtesy of *Die Naturwissenschaften*.

Maxwell and others, it is easy to combine the flow shown in Fig. 1 with a circulation of any amount, and the result is shown in Fig. 2. The circulation has produced lack of symmetry above and below a horizontal line through the centre of the cylinder, but has not disturbed symmetry about the line BB'. By an application of Bernoulli's theorem it may be deduced that there is a force along BB' but none at right angles

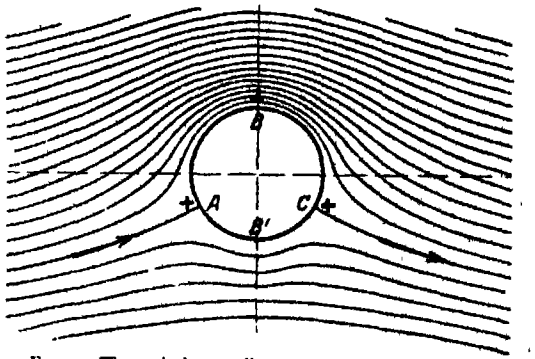


FIG. 2.—Theoretical streamlines round a rotating cylinder. Reproduced by courtesy of *Die Naturwissenschaften*.

to it. Bernoulli's theorem as applied to an inviscid fluid gives a relation between pressure, velocity, and density, which shows that high velocity is associated with low pressure, and vice versa. Above the cylinder, at B, the streamlines are close together, and since the same amount of fluid passes between any two consecutive lines, the velocity is high and the pressure low. Similarly the pressure at B' is high.

The general theory of inviscid flow with circulation leads to the formula

Lift = Force across the direction of motion = $\rho V \Gamma$ per unit length,

where ρ is the density of the fluid, V, U, and r have

[1] "Das Rotorschiff und seine physikalischen Grundlagen." Von J. Ackeret. Pp 48+7 Tafeln (Göttingen Vandenhoeck und Ruprecht, 1925.) 1·80 gold marks.
[2] "Hydrodynamics," Lamb, Articles 68 and 69.

already been defined, and l is the length of the cylinder. Strictly speaking, l should be the length of that part of an infinite cylinder on which the force is measured, but it appears from experiment that a cylinder of moderate ratio of length to diameter can be used if discs of double diameter are attached to the ends; a circulation is then obtained which is equivalent to that on a cylinder of indefinite length.

As the speed of rotation increases, the streamlines change their character progressively up to a limit. When the circumferential velocity is twice the velocity, a limit is reached to the value of the lift divided by ρUV, and in aeronautical language this leads to a limiting value of the lift coefficient defined as

$$\text{Lift coeff., } i.e.\ k_L = \frac{\text{Lift}}{\rho V^2 \times \text{projected area of cylinder}}.$$

This limit, or maximum lift coefficient, is 2π. The quantity is important, because the loading of an aeroplane per unit area of surface at a given speed is proportional to k_L or, conversely, for a given loading the landing speed is inversely proportional to the square root of k_L (max.).

The more efficient aeroplane wings of the day have a maximum lift coefficient of about 0·6 and may reach 0·85; by introducing a number of slots Mr. Handley Page has obtained the highest values known, about 2·0. From figures at Göttingen given by Ackeret, it appears that the maximum lift coefficient for a sail is about 0·4. All these values are much below the theoretical value of 2π, *i.e.* 6·28. Making allowance for partial failure of the theory, it still remains true that the loading per unit area of a rotor cylinder may be ten times as great as that on a sail and several times as great as that on any aeroplane wing in use.

It may be of interest to point out the existence of a conformal transformation by Joukowsky by means of which the circle of Fig. 2 can be transformed into a section very like that of an aeroplane wing. Experiments at the National Physical Laboratory have shown that such a transformation gives a passable representation of facts but that the lift is overestimated by 25-30 per cent. A circulation has been shown to exist of exactly the right amount to explain the measured—as distinct from the calculated—lift. An aeroplane wing, therefore, is able to produce circulation without any movement of its surface corresponding with the rotation of the cylinder. The transformation is important in its aeronautical aspects, but the numerous points of interest which arise cannot be further discussed here.

It is interesting to see how far the predictions of this partial theory are borne out in practice. In some respects there is a considerable divergence between German and American results, and a suspicion that the experiments in the wind channels have not yet been carried out on a scale large enough to reach limiting conditions. The doubts chiefly affect the resistance.

In the American tests, smoke jets were used to indicate the flow of air, and Fig. 3 shows how rotation of the cylinder (clockwise) deflects the air. The symmetry about a vertical line through the centre of the cylinder is not perfect, and the streamlines suggest resistance as well as lift. The extent to which air is carried to the back of the cylinder at the higher speeds of rotation is a notable feature shown by the photographs.

Measurements of lift showed a maximum lift coefficient of 4·5 (theoretical value 6·28) when the peripheral speed was about four times the forward speed. Instead of the maximum value of 6·28 when the peripheral speed was twice the forward speed, observation gave a value of 2·0. These comparisons show to what extent the neglect of viscosity in the theory has vitiated the conclusions.

It will be noticed that high speeds are required at the surface of the cylinder to give the maximum effect.

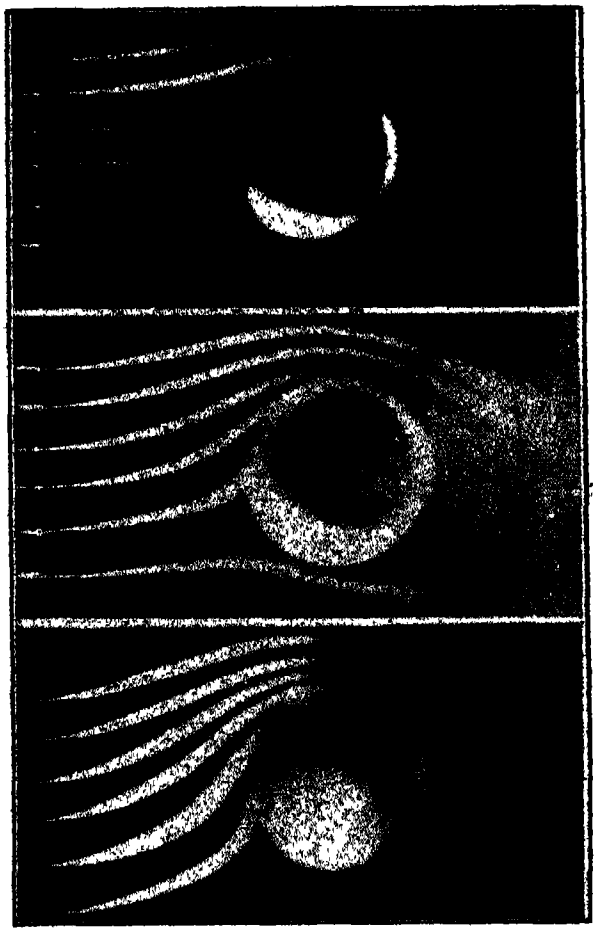


FIG. 3.—Deflexion of air stream by rotating cylinders: top, 600 rev. per min., middle, 1200 rev. per min., bottom, 2400 rev. per min. Reproduced by courtesy of *Flight*.

Regarded as an aeroplane wing, such high speed would be required at the moment of landing, and if an alighting speed of 30 m.p.h. is aimed at, the surface of the cylinders would need to move at 120 m.p.h. For transport efficiency when once in the air, the factor of greatest importance is the ratio of lift to drag, and on a rotating cylinder this is obtained when the peripheral speed is about two and a half times as great as the forward speed. Whilst the Göttingen results give a maximum ratio of 3·5, the American figures give 7·5-8, and the discrepancy is very great. The figures are subject to a deduction for the power required to rotate the cylinders, a deduction of rather uncertain amount but of the order of a quarter to a third of the

values stated. The modern aeroplane has a ratio of lift to drag of 9, and some of the light aeroplanes indicate a figure as high as 12 or 14, so that the best of the results on rotating cylinders compare very unfavourably with the aeroplane for efficiency.

Whatever may be the final utility of the rotating cylinder and the commercial fate of the *Buckau*, it may be expected that many attempts will be made to utilise the aspect of fluid motion brought into new prominence by the rotor ship. Whilst it is difficult to see immediate uses in aeronautics, there are certain directions in which speculation suggests the possibility of early benefit by a modified application of the principles involved in the propulsion of the rotor ship.

The Mountain Structure and Geographical Relations of South-Eastern Asia.[1]

By Prof. J. W. Gregory, F.R.S.

THE greatest mountain system in the world is the Alpine-Himalayan, which forms the backbone of Europe and Asia. Its continuity has been proved from western Europe to eastern India. Its further eastward continuation has long been subject of controversy. According to one view it passed northeastward across central China to Bering Straits; according to another it was bent round against the mass of Chinese Tibet, and passed through western Burma to Sumatra and thence along the southern islands of the Eastern Archipelago. The interpretation of the mountain structure of Chinese Tibet is complicated by being due to movements at two different dates. The later mountains are of the same age as the Alps and Himalaya and are geologically modern. The other group is much older, and its fragments remain as highlands, which are the worn down stumps of the mountain foundations. The older system is represented in Europe by the Hercynian Mountains, and in Asia by the Altaids, members of which cross Chinese Tibet on lines approximately north and south, and continue southward as the Indo-Malayan Mountains. The Himalayan and Altaid Mountains meet in Chinese Tibet, and the mountain lines due to these two systems have to be carefully distinguished. The Himalayan movements have disturbed the grain due to the older Altaid folding and they admit of simplest proof where the rocks were not in existence when the Altaid Mountains were made. For example, the folds and overfolds in the salt-bearing red sandstones of Yunnan must be post-Altaid, as those rocks were not in existence until after the Altaid movements. In other places the evidence is more complex. Some of the folds are too shallow to be Altaid, and the arrangement of the outcrop of the older rocks indicates upfolds on lines with the Himalayan trend.

The further extension of the Himalayan line eastward of Chinese Tibet is indicated by the claim of the French geologists in Tonkin that at the date of the Himalayan movements a band of country in southern China was pushed southward smashing the country in front of it. The existence of a rich mercury field in south-western China is also in favour of the country having been disturbed by intense mountain movements of the Himalayan period. The continuation of the main Alpine-Himalayan axis therefore appears to pass across southern China, and the Burmese-Malayan Arcs must belong to a loop to the south corresponding to the Atlas-Apennine loop around the western Mediterranean and the Syrian Arc beside the eastern Mediterranean.

[1] From a discourse delivered at the Royal Institution on Friday, January 30.

The traditional cause assigned to such folding as that of the Alps and Himalaya is the contraction of the crust owing to the shrinkage of the earth. That theory has been repeatedly criticised in recent years owing to the contraction having been attributed to cooling; but there are more effective and more probable causes of contraction than cooling. That contraction has taken place is proved by the geological evidence. The restriction of the Alpine-Himalayan compression to a long narrow band, varying in latitude from 40° to 48° in Europe, and from 25° to 38° in Asia, is the natural result of that sinking of the northern dome of the world which is shown by the polar flattening. The junction of the northern dome with the tropical belt is naturally one of crumpling and crustal disturbance. This process would produce uplifts in the same zone of the crust around the northern hemisphere, and traces of this continuous upheaval are found. The West Indies and Central America include fragments of mountain chains formed at the same time as the Alps and with a similar trend

The abrupt ending of the mountain grain of the continents on both sides of the Atlantic indicates the former extension of the land into the ocean. That the land once crossed the whole width of the Atlantic is supported by the biological evidence. Similar animals are found on opposite sides of the Atlantic in corresponding latitudes, and the resemblances of the South American and African faunas are not likely to be due to passage via Scotland and Greenland if there are no representatives of those groups in Europe or North America. The distribution of the ridges and deeps on the North Atlantic floor indicates uplifts in North America and western Europe at the time of the Alpine movements. There is similar evidence of former land extensions across the northern and southern Pacific, such as the occurrence of the alligator in the Yangtze Kiang, the resemblance of the flora of southern China to that of the south-eastern United States, and the occurrence on both sides of the South Pacific of various groups which are unrepresented in the lands on either side of the North Pacific. The biological evidence is supported by the ridges on the Pacific floor and the distribution of the coral islands. The former trans-Atlantic and trans-Pacific connexions must have endured until the time of the Alpine-Himalayan uplifts, for they were broken before the spread of the more specialised mammals and birds, and were available to some living groups of reptiles, amphibians, and specialised invertebrates.

The Indian Ocean was also once occupied by land, the disruption of which has affected the mountain structure of south-eastern Asia. At the end of the

Altaid uplifts the site of the Indian Ocean was covered by a continent which extended from South America across the Old World to Australia. This continent, Gondwanaland, was broken up by successive subsidences; and the gulfs thus formed were gradually enlarged by further subsidences and so developed into the Atlantic and two basins of the Indian Ocean. These movements were accompanied by volcanic eruptions which deluged equatorial Africa and western India under floods of lava, while East Africa was torn asunder by the formation of the Great Rift Valley. If these eruptions and fractures were due to the formation of the Indian Ocean, it appeared strange that no corresponding phenomena were known on its eastern side. The evidence, however, is now clear that in Burma and western China there were volcanic eruptions which, though on a smaller scale, agree in date with the three main volcanic periods of East Africa; while meridional fractures of the same date as those which made the Great Rift Valley formed the great basins of Yunnan in western China. These fractures in Asia produced features different in some respects from those of East Africa, owing to the difference in structure between the continents. East Africa is an ancient solid plateau, whereas Yunnan has an extremely complex foundation due to the intersecting mountain folds. The fractures have therefore been less regular and shorter.

The date of the later movements in Chinese Tibet is indicated by the river system. The drainage of south-eastern Tibet collects into three rivers which flow for 140 miles on parallel courses through a narrow belt, and instead of joining they then diverge, the Yangtze discharging into the China Sea 2000 miles from the mouth of its neighbour, the Salween The present river system is the result of a long evolution controlled by the mountain-forming movements. The drainage of central and south-eastern Asia in pre-Himalayan times was probably mainly through broad east to west trending valleys due to a gentle buckling of the earth's crust. The Himalayan movements confirmed this system; but during the subsequent settling down of the country the eastward outlet of the Tibetan rivers was reduced and Tibet became a land of lakes, to an extent even greater than it is now. Their level rose until they found outlets to the south, through lines of weakness along the Altaid grain. The Tibetan rivers through these southern outlets discharged to the South China Sea. The upper Brahmaputra or Tsangpo discharged through the Dihang, crossed the site of Assam, and passed through the Hukong Gap to the Irrawadi. The Tibetan section of the Yangtze Kiang flowed through Tali Lake to the Red River of Tonkin. Further earth movements broke up this system and diverted its western member through the valley of Assam as the Lower Brahmaputra to the Bay of Bengal, and the eastern by a series of deep gorges and striking zigzags across eastern China to the South Pacific.

The geographical relations of the mountains of south-eastern Asia therefore indicate that the Alpine-Himalayan System is a crumpled band of the crust, where the in-sinking northern dome of the world pressed against the tropical belt. The east to west ridges on the floors of the North Atlantic and North Pacific may be attributed to the same forces as produced the Alps and the Himalaya; and the east to west trending mountains, of which remnants are the dominant features in the topography of the West Indies and central America, are also an expression of the buckling of the crust of the Northern Hemisphere where the northern dome of the earth meets its tropical and subtropical belt.

Recent Developments in the Nitrogen-fixation Industry.

WHEN the historian of the future writes concerning the influence of scientific discovery and achievement upon civilisation, we may be sure that he will have much to say about the political and economic effects of the development of the nitrogen-fixation industry. Of all the material factors that helped to make the War the greatest and most devastating conflict in human history, the possession by the Germans of adequate plant for making synthetic ammonia, and of adequate personnel for working it, was probably the most important. Since that time the processes for fixing atmospheric nitrogen have been further developed, and the present yearly production of fixed nitrogen is approximately 500,000 metric tons, three-quarters of which is made in Germany.

The arc process, the lineal descendant of Cavendish's initial discovery in 1783, now contributes only a relatively small proportion of the total production, namely, about 36,000 m.t., its high power-requirement rendering it uneconomical save in countries possessing cheap and abundant water-power. The modification of the process involving the use of oxygen-enriched air, which was worked principally in Switzerland and Germany until 1921, had to be abandoned owing to the serious explosions to which it gave rise. The Swiss Nitrum Co., which worked it on a large scale, has recently adopted the Claude process in its stead.

Fixation by means of calcium carbide was developed enormously during the War, but the present outlook for this method is not promising: calcium cyanamide has not come up to expectations as a nitrogenous fertiliser, and the power-requirement, although only about one-fifth that of the arc process, is 3-4 times greater than that of the direct synthetic-ammonia process. The output of cyanamide has declined to about 140,000 m.t. per annum, and about one-half of the world's plant capacity is unutilised. There are, however, still possibilities, for cyanamide can be used as an intermediate product in the manufacture of urea, of ammonia, and of "Ammo-phos," a fertiliser made on a small scale in the United States.

Urea appears to be the nitrogenous fertiliser of the future. It is the most concentrated of its class; it can be transported and used without difficulty; it leaves neither acid nor alkali behind in the soil; and it has given general satisfaction in experimental work. It will probably be manufactured by combining synthetic ammonia and carbon dioxide at high temperature and pressure. Since 1922 a combination of urea and acid phosphate, called "Phosphazote," has been made in Switzerland, and a large works in Norway is to start its production early in the current year.

The Haber process and its modifications, involving the direct union of nitrogen (from liquid air) and

hydrogen in presence of a catalyst, at various temperatures and pressures, now contribute about 65 per cent. of the world's supply of fixed nitrogen. In this process the cost of producing and purifying the hydrogen is a dominating factor; in Germany it is prepared from water-gas (Bosch process), in France by fractionating coke-oven gas (Claude process), and in Italy by electrolysing water (Casale and Fausser processes). Electrolytic hydrogen is very pure, but its production is only feasible where water-power is cheap. The Casale process is being actively worked in Calabria by a company with a capital of 9 million Swiss francs, and in the United States the Hooker Chemical Co. is so satisfied with its success that it has decided to double its plant at Niagara Falls.

Other important factors in the Haber process are the choice of catalysts and the form of marketing the ammonia. In the Fixed-Nitrogen Research Laboratory of the United States Government, improved catalysts have been made which, it is expected, will reduce the cost of ammonia-production by one-half; working on a small scale, at 1500 atmospheres pressure, nearly 80 per cent. of a nitrogen-hydrogen mixture was converted during a single passage through the catalyst. Improved catalysts have also been made for the water-gas reaction ($CO + H_2O = H_2 + CO_2$). With these and other improvements it is hoped to reduce the price of ammonia to 5-6 cents per lb.

At Billingham-on-Tees, Synthetic Ammonia and Nitrates, Ltd., has started manufacture on a large scale. A modified Haber process is used, and the ammonia is fixed by the calcium-sulphate method, which was developed, and is still used, in Germany. It is probable that synthetic ammonia will be used in conjunction with the Solvay soda process, the ammonia being converted into ammonium chloride, which preliminary trials have shown to be comparable with ammonium sulphate in fertilising value.

The Bucher process of fixing nitrogen as cyanide has not fulfilled expectations, but it appears probable that the du Pont Co. will make it a success. Instead of passing nitrogen (at 15 lb. pressure) over soda ash, coke, and a catalyst, this company uses producer-gas and a mixture of carbon black and soda ash (plus catalyst) obtained by evaporating to dryness the "black liquor" which results from boiling wood with caustic soda in the manufacture of wood-pulp, and by heating the residue out of air at 250°-350° C. This mass is very porous, and contains 60-65 per cent. soda ash and 40-35 per cent. carbon, mainly colloidal. The yield of cyanide at this stage is 50-55 per cent., and the period of heating is only 70 per cent. of that required in the original process. The reaction-product is leached with water, and 96-98 per cent. sodium cyanide is obtained by crystallisation. The carbon monoxide evolved during heating is mixed with producer-gas and burned under the retorts, which are made of very resistant cast chrome-iron alloy, high in chromium. A valuable decolorising carbon is extracted from the residue after leaching. Cyanide, it may be mentioned, can be decomposed by steam to yield ammonia.

The marvellous growth of the nitrogen-fixation industry has naturally excited those interested in the production of Chilean nitrate, the consumption of which has not advanced *pari passu* with that of the artificial products; but the processes used in Chile are known to be wasteful, the Chilean Government could reduce the export tax of 50*s.* per ton in case of emergency, and the deposits are likely to last much longer than was originally thought probable. In view, however, of the fact that no other nitrate deposits, in any way comparable with those of Chile, have been discovered, it can only be a question of time—a generation or two—before the synthetic products will hold undisputed sway. It is, of course, possible that means may be found of speeding up nitrification in the soil, but even in that event no nation could afford to be without a nitrogen industry for producing explosives. Furthermore, fixed nitrogen is being increasingly used as ammonia for cold-storage plants, as cyanide for gold extraction, and as nitro-cellulose for making celluloid, artificial leather, and similar products. Great developments of the industry may, therefore, be confidently anticipated.

Obituary.

The Marquess Curzon of Kedleston, K.G., F.R.S.

BY the death of Lord Curzon, Lord President of the Council, and formerly Viceroy of India and Secretary of State for Foreign Affairs, on March 20, public life in Great Britain has lost one of its most striking personalities. His long and distinguished career in politics had won him high honours in the State; but in a more restricted circle he was held in equal esteem for his scholarship and his efforts to promote those studies with which his interests and pursuits had brought him into touch.

George Nathaniel Curzon, son of Lord Scarsdale, was born on January 11, 1859. After a distinguished career at Eton and Oxford, which included the presidential chair of the union and led to a fellowship of All Souls, Mr. Curzon, as he then was, embarked on a political career, entering Parliament in 1887, first holding office as Under-Secretary of State for India in 1891, by which time he was already recognised as an authority on the East. It is unnecessary to enter here into the details of his political career, which are well known. His services to the State were recognised by successive peerages of every grade up to the rank of marquess and the orders of the Garter, the Indian Empire, the Star of India, and the Royal Victorian Order.

Apart from politics, Lord Curzon won distinction as a geographer and student of the peoples of the East. Between 1886 and 1894 he visited India four times and twice travelled round the world. In 1888 he travelled through Asiatic Russia, recording his observations in his book "Russia in Central Asia." He followed this with a book on Persia and the Persians, a comprehensive account and perhaps his most considerable contribution to geographical literature, which later was to have considerable effect on policy in the Middle East and is still a work of authority. This appeared after a journey in Persia as correspondent of the *Times* in 1889, in the course of which he travelled more than 1600 miles on horseback and toured the Persian Gulf. A later book, "Problems of the Far East," dealt with conditions in and the prospects of the countries lying

between India and the Pacific. In 1894 he visited the Ameer of Afghanistan—then an undertaking entailing some considerable risk—after tracing the Oxus to its source in the Pamirs. Behind his preoccupation with races and people as factors in international politics, Lord Curzon had a fund of sound geographical knowledge, and in fact, as was shown by essays in his often amusing "Stories of Travel," published in 1923, he was a scientific geographer of no small attainment. In geography and in the study of peoples, as in his work as an administrator, it was characteristic of him to pursue exhaustive inquiry and to master the available data relating to his subject before arriving at any conclusion on his own observations. The result would then be expressed with a lucidity which reflected his clarity of judgment. His contributions to geographical science were recognised in 1895 by the award of the Royal Geographical Society's gold medal, an honour which he prized highly.

As Viceroy of India Lord Curzon did much to promote science in that country. Apart from his lasting reforms in education and his efforts to improve the conditions of agriculture, both being placed under trained officers, he reorganised the archæological service, which had fallen into neglect, reviving the office of Director-General. In 1904 he passed a Monuments Act, and he saved from profanation and decay innumerable temples, tombs of kings, mosques, and other buildings throughout India, including the native states. Native arts and industries were fostered, and he created the Imperial Library in the Metcalfe Hall and was responsible for the Victoria Memorial on the Maidan, Calcutta, a gallery of Indian art and history. His own researches into the history of his predecessors in the Viceregal office were on the point of publication at the time of his death.

It may be recalled that Lord Curzon and Lord Kitchener were the principal guests of the Royal Society at its anniversary dinner in 1898. Within a few days both were due to leave England to take up their new Indian appointments. In a letter to Lord Lister, the president, a few days prior to the banquet, Lord Curzon wrote: "It is the instinct of the hunted animal to fly, but your invitation to me has been expressed so gracefully that I cannot but accept." Lord Curzon made an interesting speech at the dinner, referring, among other matters, to a Viceroy's horoscope. An outgoing Viceroy, he said, is fêted and dined and toasted before he has gone out to his work, and, indeed, before he has done anything at all. Five years later, upon his return, he slips back into Great Britain almost unperceived, and retires, very likely, into an obscurity which may or may not be merited, but is, at any rate, in striking contrast to the plaudits which attended his departure. Happily, in Lord Curzon's case, such prophecy was unfulfilled.

Lord Curzon's interest in the relics of antiquity were not confined to India. It was through his efforts that Tattershall Castle, Lincolnshire, was saved for the nation when about to be demolished, and through him the castles at Bodiam in Sussex, and Montacute in Somerset, were also preserved.

Lord Curzon was the recipient of many honours bestowed by the learned and scientific world. He was president of the Royal Geographical Society from 1911 until 1914. He was elected Chancellor of the University of Oxford in 1907, when he took a prominent part in the movement for "reform from within." He was Lord Rector of the University of Glasgow in 1908, Romanes Lecturer at Oxford in 1907, and Reed Lecturer at Cambridge in 1913. He was an honorary fellow of Balliol, and held honorary degrees from the Universities of Oxford, Cambridge, Glasgow, and Manchester. He was a fellow of the Royal Society and British Academy, and had accepted the presidency of the English Association not very long before his death.

Lord Curzon in India.

Except in so far as it had a direct influence on economic development or on humanitarian problems, Lord Curzon, during his Indian Viceroyalty, showed no marked interest in scientific research. Science did not appeal to him as a branch of culture comparable to history and literature It is true that, four years before he was appointed Viceroy, he had made a distinct mark as an explorer in the Pamirs, when he solved the problem of the source of the Oxus; but this diversion to physical geography was rather an accidental by-product in a journey mainly devoted to the political aspects of geography and sport. Still, the recognition of this work by the Royal Geographical Society left him with the impression that geography at any rate was a science, and, so far as one could guess from his official and personal activities in India, it gave him the impression also that science was geography Workers in other branches he seemed to regard as having a limited usefulness in solving political and economic problems, and sometimes in assisting his remarkable work in restoring respect for India's unappreciated relics of archæological and historical value. His action in dispersing the fine collection of fishes (which had been prepared by Col. Alcock in the Calcutta Museum), to provide an opportunity for a preliminary display of the historical collections designed for the Victoria Memorial, revealed his want of appreciation of the claims of those forms of culture that had had no part in his earlier education. Fortunately, no other science workers offered obstacles to his activities, and so they could not share to the full the resentment displayed by the zoologists.

Nevertheless, when Lord Curzon realised that science was necessary for economic progress, he recognised the value of laying sound foundations in research which could offer no prospect of definite results in his own time. In this matter he was fortunate in having as members of his Government two Ministers—Sir Denzil Ibbetson and Sir John Hewett—who realised that the development of pure science was essential to solid advancement in its application. Lord Curzon's institution of the Imperial Agricultural Department, by recruiting into one service a strong staff of chemists, botanists, plant pathologists, entomologists, and other specialists devoted to agricultural problems, has already brought to the Indian cultivator direct returns in increased output annually, many times more than the total cost of the new service from its start.

Although most science workers in India during the years 1898 to 1905 remained outside the Viceroy's wide range of active interests, the wiser among them realised that their position was not without some advantages; his zeal for reform was dominated always by a desire for centralised control and symmetry in system of administration—conditions which may have conduced

to increased efficiency, but were never accomplished without trespass on local sentiment or without interference with individual liberty in research work. Fortunately, he found urgent problems in other fields, even more than enough for his apparently unlimited energy and never-failing sense of duty.

In the *Sunday Times* of March 22, Mr. Newman Flower mentions the fact that the night before his operation, which he knew might be fatal, Lord Curzon wrote minute instructions about his forthcoming book on "British Government in India," and this incident reminded me of a somewhat similar illustration of his remarkable regard for small things in spite of greater distractions. In 1905, when the controversy with Lord Kitchener, which led to his resignation, was at its height, Lord Curzon sent me long notes from Simla about certain marble pedestals in Government House which he had asked me, during the previous Calcutta session, to take a personal interest in and to have erected before the arrival of the Prince of Wales.

It was not until after 1916, when war conditions forced upon one many duties of an unfamiliar nature, that one saw further direct evidence to show the great depth as well as width of Lord Curzon's marvellous activities in railway extension, in university education, in public health, in town-planning, in industrial developments, in army administration, and, most remarkable of all, in the complex problems of land revenue which not even an experienced member of the Civil Service professed to understand for any but his own province. His views were expressed in reasoned notes that left one with the impression that each file in turn covered the one subject in which he had specialised. Five years' experience with the Government of India, where the records of his previous work are filed, left me with two outstanding impressions—first, an inexpressible admiration for his energy, thoroughness, and conscientious devotion to India; and secondly, an equally strong feeling of thankfulness that geology was not one of the subjects in which he had occasion to specialise between 1898 and 1905. T. H. HOLLAND.

PROF. A. VON WASSERMANN.

WE regret to record the death on March 16, at sixty years of age, of August von Wassermann in Berlin. He was born in Bamberg, and having studied in Strasbourg, Vienna, and Berlin, early became associated with the Institute for Infectious Diseases under Koch, and it was here that most of his work was done. He ultimately became Director of the Serum department of Koch's Institute, and in 1913 Director of the large Institute of Experimental Therapy of the vast Kaiser-Wilhelm Gesellschaft zur Forderung der Wissenschaft in Dahlem, Berlin. He was also honorary professor in the University of Berlin and was ennobled in 1910.

Von Wassermann's scientific life-work was done in the domain of immunity; he saw its rise and zenith and contributed in no small degree to its development. He was an exceedingly clever man, untiring in his diligence, and in the highest degree efficient if lacking in imagination when compared with the greatest workers in his science. Throughout the development of immunity problems he was constantly on the alert, and felt almost every pulsation of advancement of knowledge with extraordinary acumen. Although rarely the first on the field, he was almost invariably among the first to take full advantage of anything new, and he always added something fresh and clever to work already done. He was a typical "Prussian," somewhat arrogant to his inferiors, but withal a man that was liked. He was a brilliant speaker, and a great star at medical gatherings and congresses, where he was always listened to with attention. As an example of his diligence we may cite the "Handbuch der pathogenen Mikroorganismen" which he edited with W. Kolle. This monumental if somewhat uncritical work appeared in two editions, the first in six volumes between 1903 and 1909, the second in eight volumes with nearly nine thousand pages, all of which was published within two years (1912–1913).

From 1906 Wassermann attained world-wide fame, and his name became almost a household word through his discovery of the so-called Wassermann reaction in the diagnosis of syphilis. In its altered form, this test is practised in every pathological laboratory the world over, and is perhaps the most accurate laboratory test applied to the clinical diagnosis of disease. Wassermann's test was the practical application of a fundamental principle discovered by Bordet and Gengou (1901) of Brussels, and it was characteristic of him that he saw almost immediately how Bordet's work could be utilised for human medicine. Wassermann's name will live long in the annals of bacteriology and immunology. W. B.

DR. WILLIAM F. HILLEBRAND, chief chemist of the United States Bureau of Standards, died on February 7 at the age of seventy-one years, and an appreciative account of his life and work by a colleague at the Bureau of Standards has been published in a recent issue of *Science*. William Francis Hillebrand spent two years at Cornell University before taking up chemistry, most of his training in which was received in Europe. In 1872 he went to Heidelberg to study under Bunsen and Kirchhoff, and from there, he and T. H. Norton published in 1875 their paper on the preparation of metallic cerium, lanthanum, and the mixture then called didymium. Hillebrand's later work showed these metals were trivalent and belonged to the rare earth group. He also discovered the pyrophoric properties of cerium filings. From Heidelberg Dr. Hillebrand went to Strassburg under Fittig, and from there to the Mining Academy at Freiburg. Returning to the United States, he was appointed to the staff of the Geological Survey in 1880, and until 1885 was stationed at Denver. Here was plenty of mineral material to exercise his growing skill as an analyst, and the work was continued after his transfer to Washington. In 1908 he became second chief of the Bureau of Standards. Dr. Hillebrand devised general analytical procedures suitable for different types of mineral and rock, and also special methods for the determination of individual elements, which were placed on record in various issues of the Bulletin of the Geological Survey; silicate rocks were dealt with in 1897, carbonate rocks in 1907, both of which were quickly translated into German. Dr. Hillebrand was a member of the National Academy of Sciences, and in 1906 was president of the American Chemical Society; for many years he served as an associate-editor of this Society's Journal and also of the *Journal of Industrial and Engineering Chemistry*.

Current Topics and Events.

OUR readers will no doubt be interested in the photograph we publish showing Prof. Raymond Dart, of the Witwatersrand University, Johannesburg, with the Taungs skull. Prof. Dart, who is well known to anatomists in Great Britain, was trained under Prof. J. T. Wilson, now professor of anatomy at the University of Cambridge, and worked in London at the Royal College of Surgeons, and under Prof. Elliot Smith at University College in 1919, where he paid special attention to problems of the brain and to the skull of fossil man. Before taking up his appointment in South Africa he was one of three selected by Prof. Elliot Smith from his staff, at



Prof. Raymond Dart with the Taungs skull.

the request of the Trustees of the Rockefeller Foundation, to visit the medical schools of the United States A certain amount of criticism has been levelled at Prof. Dart's nomenclature of the Taungs skull. It is generally felt that the name Australopithecus is an unpleasing hybrid as well as etymologically incorrect. Dr. J. G. de Barros e Cunha, of the Institute of Anthropology, Coimbra, who is among those who take exception to the title on these grounds, also writes to point out that if a new family of *homosimiidæ* is constituted, the generic name should be Homosimis, whereas the generic name, Australopithecus, would require the family name Australopithecidæ. Although it may be a little premature to decide, present information does not force either alternative upon us, as there does not seem to be adequate ground for the creation of a new family. Meanwhile the criticism continues, and in a cable which appeared in the *Times* of March 11, Prof. Dart defends himself with some humour but in a manner which suggests that the niceties of etymology do not greatly appeal to him.

PROF. L. VEGARD sends us the following cable message from Oslo, dated March 20: "Shown by experiments in mixtures of nitrogen and neon at the Leyden Laboratory that auroral line is the limit to which the band N_1 approaches by diminishing size of nitrogen particles." Prof. Vegard described his observations of the luminescence of solid nitrogen, and the structure of the two bands in the green part of the spectrum, called by him N_1 and N_2, in communications to NATURE of September 6 and November 15, 1924.

ALTHOUGH the Coal Conservation Report was issued in 1918, there is still considerable difference of opinion amongst electrical engineers as to the advisability of mapping Britain out into power zones each served by super power stations of high thermal efficiency. It is admitted that there are many small stations which burn fuel extravagantly, but in some of our larger stations the thermal efficiency is about 20 per cent and is still increasing This compares favourably with anything that has been done by the super power stations in the United States, where the power zone system is adopted. There is one aspect of the problem, however, to which more attention should be directed, namely, the possibilities of interlinking various supply systems by reversible motor-generators so that one company can help the other during times of heavy load. Even if the systems of supply be alternating current of different frequency, suitable electrical devices called frequency transformers can be used for this purpose When this is done, in nearly every case the ratio of the average demand on a station to the maximum possible demand is largely increased. The overhead charges are thus considerably reduced and will justify a reduction of price to the consumer. The linking together recently of three power stations in Berlin has had the effect of raising this ratio—the so-called "load factor"—to 57 per cent., and made possible considerable economies. The tables published by the Electricity Commissioners prove conclusively that the larger the power station the higher the thermal efficiency. The main difficulties in the way of getting a cheaper supply of electricity, and a more efficient one from the point of view of fuel consumption, are in connexion with raising the capital required for providing the necessary distribution mains. Various schemes have been suggested for overcoming these difficulties, but no general agreement has yet been attained.

THE pages of American scientific and technical periodicals have for some time provided evidence of considerable activity in the field of colloid chemistry. This is not confined to individual work, but there has been a good deal of concerted action directed towards promoting and facilitating the study of the discipline. The Colloids Committee of the National Research Council some time ago issued a fairly complete bibliography of the subject, and has now put forward a definite scheme for the establishment of a National

Institute for Research in Colloid Chemistry. The scheme itself, some of the general claims of colloid chemistry, and a number of successful applications to technical problems are described in a beautifully printed and illustrated booklet published by the University of Wisconsin. This institution puts forward a number of reasons why the proposed Research Institute should be located in its grounds, one of the reasons being the enthusiastic support given to the lectures and research classes held by Prof. The Svedberg of Upsala during part of the year 1923 and the subsequent "symposium" on the subject. The scheme suggests the raising of a sum of one million dollars, a quarter of which is to be devoted to buildings and equipment and the remaining three-quarters to endowment. A director of research, for whose specified qualifications a salary of 8000 dollars does not seem excessive, a director of the laboratory and two research fellows with salaries of 6000 dollars each, are contemplated. There is very little doubt that the money will be easily obtained, and, whatever view one may take of the possibilities of gregarious research, it is impossible to avoid slightly envious comparisons between the colloids "boom" in the United States and the very inadequate provision for teaching and research on the subject in Great Britain.

THOSE responsible for airship development in the United States and in Great Britain have drawn many comparisons with the development of marine transport. To balance their natural optimism a note of caution may be sounded. The new airships are to displace 140,000 cub. m. volume and 150 tonnes mass of air. A ship of the same volume displacement of water would have a mass displacement of 110,000 tonnes. The air leviathans are, of necessity, bubbles lighter than air. Most marine harbours have protected approaches so that in stormy weather ships pass by degrees from the waves of the open sea to completely protected waters before making actual contact with dock or quay. Where the approaches are bad in certain winds, arriving vessels may have to turn back, an experience not unknown to channel passengers. Unfortunately, all airship harbours are bad in all high winds, and if in spite of weather forecasting an airship is caught outside its shed, it must ride out the storm under power or at the mooring mast. With ships, the maximum hogging and sagging stresses increase until the length of the ship exceeds the maximum wave-length, as is the case with Atlantic liners There is no authoritative information as to the analogous air stresses, but American experience with the *Shenandoah* is held to confirm the belief that these are much greater than the stresses produced by manœuvring in still air. This, then, seems to be the ultimate standard by which the airship will be tested unless it is to remain in its shed until fair weather is predictable with certainty.

THE first manufacture of fused silica ware was a British achievement, and it is satisfactory to learn that the industry which grew from small beginnings at Wallsend-on-Tyne in the early years of this century is still flourishing and well maintaining its pre-eminent position both at home and abroad. Like many other useful inventions, the applications of fused sand and quartz to the construction of laboratory apparatus and to parts of large-scale plant developed at first with extreme slowness, but circumstances arising from the War provided the necessary impetus for their extension: the cutting off of supplies of German porcelain and the recognition of the value of silica condensing-systems for nitric-acid vapour and of silica basins for concentrating sulphuric acid were mainly responsible for the change. Since the end of the War a demand has arisen for silica cooling and absorption plant in the manufacture of hydrochloric acid, both by the old process and by burning hydrogen in an atmosphere of chlorine. Silica stills for the concentration of pure sulphuric acid have also been in request, as silica is the only material that can satisfactorily replace platinum for this purpose. By far the most important new application is the manufacture of gas globes and of bowls for indirect lighting, more fused silica being used for this than for any other purpose. In the immediate future a considerable demand for it is anticipated for making the envelopes of large thermionic valves and the condensers of "radio" sets.

THE number and variety of laboratory appliances made of fused silica are also increasing, and among the latest of these is a mercury condensation pump, which is fully described in the most recent catalogue issued by the Thermal Syndicate, Ltd., of Wallsend-on-Tyne. This pump, measuring 25 cm. in length, is made entirely of fused quartz, and worked in conjunction with a backing pump giving a vacuum of 0·2 mm. of mercury, it provides a vacuum of 0·000002 mm.; it is operated with only 5 c.c. of mercury, can be heated either by gas or electricity, and is water-cooled. The increased use of fused silica ware for scientific and technical purposes would appear to depend mainly upon its price. It is not easy to manufacture; skilled labour is essential, the necessary electrical equipment is costly, and only very pure raw materials, such as sand from Fontainebleau and quartz crystals from Madagascar, can be used. In spite of these circumstances, considerable progress has been made in reducing production costs, and only a big demand is needed to permit of an appreciable reduction in selling price, and to enable silica ware to compete in price with materials which have hitherto been thought to be much easier to produce. The opacity or translucency of articles made from sand is known to be due to the presence of small air-bubbles and not to impurities in the raw materials. These air-bubbles cannot be expelled because the fused sand is very viscous; melted quartz-crystal, on the other hand, is quite mobile. The translucent material is, however, quite suitable for most objects, especially when these are glazed, and for some purposes, for example, the manufacture of gas globes, it is to be preferred.

THE British Non-ferrous Metals Research Association has just issued a report on the research work in

progress or completed under the auspices of the Association. The record is a striking one. A graph which is attached to the pamphlet shows that the expenditure on experimental research, which in 1921, the second year of the existence of the Association, was only 1500*l.*, will amount during the present year to close on 16,000*l.* The most interesting feature of the report is the attention given to the scientific study of alloys. The Council of the Association has taken a very broad view, and most of the work is devoted to fundamental problems rather than to the solution of immediate workshop difficulties It has been decided to establish a small central laboratory, attached to the University of Birmingham, for the use of the Superintendent of Research and also for carrying out preliminary investigations, but the policy of the Association is to have its researches conducted mainly in the universities and other specially equipped laboratories of the country A glance through the pamphlet shows that at least thirty separate research workers are engaged in various laboratories under the supervision of their respective professors or directors. The non-ferrous metal industry is an extensive one, and there are still branches of it which are not represented in the Association; firms which have not yet seen the benefit of co-operative research of this kind cannot do better than study the present pamphlet. One consequence of the present programme, of interest to physicists as well as to metallurgists, will be the exact determination of the physical properties of many non-ferrous metals and alloys, a subject on which information at present is singularly imperfect, as will be realised by any one who consults the standard volumes of tables of physical constants.

"WINDOLITE" is the name given to an aceto-cellulose wire-net reinforced substitute for glass. It offers a very thin film in the meshes of the wire net, and transmits the ultra-violet rays. One sample tested transmitted light right down to 232 $\mu\mu$, while ordinary window glass cuts off rays shorter than about 330 $\mu\mu$. The most active biological rays, so far as the skin is concerned, are about 300-290 $\mu\mu$, and these are the rays which come through with the high sun on clear days. Windolite should be useful for open-air shelters, verandahs, etc. The makers inform us that gardeners find it draws plants less than glass, and that this is not due to great coolness of the garden frame or house. It should be interesting to see how well plants grow under it, and whether the anti-rachitic substance and the growth vitamin A are present more in plants grown with ultra-violet rays than without. The present writer has tried cress, and so far has found no difference on young rats in the growth-promoting power, but that may be due to vitamin A derived from the seeds. Hess in the United States states that market salad has not got anti-rachitic power, but can be given this by radiation. A new glass has also been submitted to us—Lamplough's Vitaglass; this as rolled is a "cathedral glass," but it can be blown clear. It lets ultra-violet rays through down to 275 $\mu\mu$, costs about 3*s.* a square foot, and should be useful for skylights, verandahs, upper parts of windows of hospitals, sanatoria, schools, nurseries, and possibly for greenhouses if fruit and salads are found to be improved in quality by ultra-violet rays. Blown clear it will be useful for bulbs of tungsten filament quartz lamps, allowing us to get some gentle ultra-violet rays from these.

A DESTRUCTIVE tornado struck Annapolis, Missouri, shortly after 1 o'clock in the afternoon of March 18, swept north-eastward across the Mississippi River, traversing Southern Illinois, and at Elizabeth, Indiana, broke into two lesser storms, which tore pathways through Tennessee and Central Kentucky. The *Times* reports that many towns were completely cut off from communication with the outside world, and others were threatened with destruction by fires which broke out among the ruins. Murphysboro, De Soto and West Frankfort in Illinois, Griffin, Owensville and Princeton in Indiana, and Witham in Tennessee are said to have borne the full force of the storm. At South Greenfield, Illinois, a passenger train was overturned by the wind and several persons were killed. In one place about 50 motor-cars were piled in a tangled ruin. Illinois seems to have been the heaviest sufferer, with 645 known dead and 1945 injured. The latest ascertained figure, to March 20, for all five States is 823 dead and 2990 injured, but many bodies are still buried in the wreckage. The storm tore its way over a length of 150 miles. Often its path was only 300 ft. wide. There are places where it uprooted oak trees a foot thick and split apart heavy stone buildings, but left unscathed flimsy cottages and mere shacks.

THE annual report of the Meteorological Office, Air Ministry, for the year ended March 31, 1924, has recently been published. It is the sixty-ninth year of the Office and the fourth year that the cost of the Office has been borne by the Air Ministry. The report shows a large increase in the staff in comparison with a few years ago, as well as an immense increase in the work undertaken. A good deal of reorganisation has been taken in hand The Office has apparently attained its normal condition and little further development is expected for some years Details are given of international work, especially in relation to a common system of reports required for purposes of aviation. The Marine Division has achieved fresh work, including the establishment of the *Marine Observer* and the *Weather Shipping* wireless bulletin Much weather information is gathered for all oceans from voluntary observers. The Forecast Division has made some progress; 84 per cent. of the gale warnings for the whole of Great Britain were followed by gales or strong winds. The ordinary daily forecasts can be obtained, free of charge, by telephone or from broadcasting stations. The Climatological Division deals primarily with the weather of the British Islands, and numerous observations are gathered from all parts of the globe. The Office is interwoven with the Navy, the Army, and the Air Force. Much research is made with regard to the upper air; 8360 single-theodolite pilot-balloon ascents were made during the year, and 236 aeroplane ascents were made by pilots of the

Royal Air Force to determine upper-air temperatures and humidities. The British Rainfall Organisation and observations in connexion with atmospheric pollution afford much valuable material of general utility.

DURING the course of the Pasteur centenary celebrations, held in May 1923, a Pasteur "day" was held throughout France, when badges were sold in aid of the scientific laboratories of the country. Some nine million francs were collected in this way, while the *Matin* raised a further three million francs by subscription A committee under the chairmanship of M. Émile Picard, permanent secretary of the Paris Academy of Science, was appointed to distribute the fund, and a list of the allocations has recently been issued. Grouping the awards according to subject, they are as follows . 2,143,000 francs to physics, of which 1,000,000 francs is reserved for the construction of a powerful electromagnet for the Paris Academy of Sciences, 1,340,000 francs to chemistry; 1,150,000 francs for astronomy, of which 650,000 francs will be for a photographic instrument and for a reflector of 1·20 m aperture, 160,000 francs to mathematics, 120,000 francs of which is for the publication of the works of Henri Poincaré; 190,000 francs to meteorology, 245,000 francs to geography and navigation; 333,000 francs to geology and mineralogy, 630,000 francs to zoology, 640,000 francs to botany; 576,000 to physiology and medicine; 105,000 francs to microbiology, 75,000 francs to agriculture, 600,000 francs for the general biology of the Colonies; 510,000 francs for industrial research and institutions. The three million francs collected by the *Matin* is to be invested and the interest used for prizes and grants. The complete list of the grants appears in the *Revue scientifique* for February 28

THE fourth annual report, just presented, of the National Institute of Industrial Psychology shows a most interesting development of the work in many directions The application of scientific knowledge and methods to industrial problems cannot fail to have far-reaching results not only for the firm or industry studied, but also for the sciences applied for the elucidation of its problems; in the course of the application of the scientific principles new data will be available whereby knowledge will be extended. The investigations for the year cover a very wide field—coal-mining and chocolate-making, dressmaking and restaurant breakages, to mention but a few. The problems studied have involved—protection from extreme heat, effects of long standing, the mental irritation and worry in connexion with breakages, ventilation and atmospheric pollution. Not the least important part of the Institute's work is concerned with the guidance of children just leaving school; this aspect has been considerably enlarged during the year, owing to a generous grant from the Carnegie United Kingdom Trust, and research work is in progress The Institute is also conducting an educational campaign by means of lectures and meetings for both scientific and industrial audiences.

THE Textile Institute, the headquarters of which are at St. Mary's Parsonage, Manchester, with London branch office at 38 Bloomsbury Square, has now received a Royal Charter of Incorporation granted by His Majesty's Privy Council by Letters Patent under the date of March 11. The Charter will enable the Institute, in addition to its other powers, to hold examinations and to grant certificates of competency to practise, teach, or profess textile technology. The Institute was formed in 1910 and registered under the Companies (Consolidation) Act, 1908, as a company limited by guarantee. For several years past the question of qualifications in connexion with membership has been under consideration, but it was not until the existing president, Mr. John Emsley, of Bradford, came forward with a definite proposal, accompanied by a generous offer, that it was decided to petition for a Royal Charter of Incorporation. The object of the Institute in adopting this course was to secure not only a higher general status for the organisation, but also that fellowships or associateships which may be granted shall be issued under satisfactory conditions of authorisation The annual general meeting and spring conference is to take place at Manchester on April 29, whilst the annual conference will be at Edinburgh during Whit-week next. At Edinburgh, the Mather Lecture of the Institute will be given by Prof. A J. Sargent, of the London School of Economics, whose subject will be "The World Problems of Wool and Cotton."

AT the annual general meeting of the Geological Society of London, held on February 20, the following officers were elected. *President*, Dr. J. W. Evans; *Vice-Presidents*, Dr. J. S Flett, Sir Thomas Holland, Prof. A C. Seward, and Sir Arthur Smith Woodward; *Secretaries*, Mr. W. Campbell Smith and Dr. J. A. Douglas; *Foreign Secretary*, Prof. J. E. Marr; and *Treasurer*, Mr. R. S. Herries.

THE Ordnance Survey has published Sheet 44, Mull, of the coloured printed one-inch geological survey of Scotland. The sheet covers an area of involved geological detail and is a beautiful example of fine colour printing. The number of colours used is considerable, and some of them appear in very small area, but the register and general cartographical technique show no flaw throughout the sheet.

WE have received from M. Jacques Boyer, 5 bis, rue Saint-Paul, Paris, a copy of the fourth edition of his "Catalogue de photographies documentaires." It gives a list of the photographic illustrations that he can supply relating to scientific, industrial, and military matters, agriculture, horticulture, geography, aeronautics, automobilism, and portraits of savants and technologists. This last section alone consists of about five thousand portraits, historical characters being taken from the most authentic records. The list of this section is not given. The few sample reproductions included are of excellent quality.

A NEW edition, No. 924, of a catalogue of petrological microscopes issued by Messrs. James Swift and Son, Ltd., 81 Tottenham Court Road, London,

W.1, contains a large and comprehensive collection of microscope outfits for use in petrology, mineralogy, and crystallography The list includes instruments suitable for elementary students, as well as more elaborate types adapted for the most exacting investigations A petrological microscope, being an instrument for observing and measuring the optical properties of rocks, minerals and crystals, requires many special fittings and adjustments which are not necessary in a microscope for use in the biological sciences The models described in the catalogue have been designed primarily for petrological work, and incorporate many of the latest devices for simplifying adjustments and for securing rigidity and accuracy

MESSRS Bernard Quaritch, Ltd , 11 Grafton Street, W 1, have recently circulated Catalogue No 390 dealing with nearly 1900 second-hand works on zoology, botany (including agriculture, forestry, fruit-culture and gardening), and geology As is usual with the catalogues of this bookseller, many choice and rare publications are listed

MESSRS W Heffer and Sons, Ltd., 4 Petty Cury, Cambridge, have just published a lengthy and well-arranged catalogue (No. 248) of second-hand works in the following branches of science —Mathematics and physics, astronomy and meteorology, engineering, wireless telegraphy, agriculture, husbandry, and farriery, anthropology and ethnology, botany, chemistry, chemical technology and metallurgy, geology, mineralogy and palæontology, zoology and biology, physiology, anatomy and medicine Upwards of 3500 books are named, and in addition there is a long list of complete sets of scientific serials which Messrs Heffer have for disposal The list is to be had upon application

Our Astronomical Column.

THE BEGINNING OF THE JULIAN DAY —There is a lamentable state of confusion in the astronomical world as to whether the Julian Day should begin at noon or midnight Some countries, following the lead of the United States, have decided on beginning at midnight But the Astronomical Society of the Netherlands continues the noon reckoning, and many people in the British Isles propose to do the same, some of these quote the fact that no change has been made in the Julian Day table of the Nautical Almanac as registering an official decision in this sense The fact is, however, that no such decision has been reached, and in its absence the wording of the Nautical Almanac remains as before

While it is possible to make a good case for either noon or midnight, the use of different systems in different countries cannot fail to be a source of great confusion, and it is earnestly to be hoped that an official decision will be registered by the Astronomical Union at its meeting in July The present year must in any case be one of confusion, but the sooner that state is ended the better.

THE TOTAL SOLAR ECLIPSE OF JANUARY 24.—The *Scientific American* for March describes this as "the best observed eclipse in history." It was certainly the most populous region that the moon's shadow has traversed since modern methods have been introduced, and the article states that thousands of volunteer observers were engaged in observing the exact limits of the zone of totality and similar researches. Five successful colour photographs of the corona were obtained, and the reproduction of one of them is promised in the next issue "The great spectacle was not marred by so much as a single wisp of cloud."

The times of the beginning and end of totality were telegraphically recorded on two chronographs, one at New Haven, the other in New York, this facilitated the rapid comparison of results, which were thus available in the cable message despatched to Europe the same day. The main feature of the eclipse as a whole was the eager co-operation of thousands of people in a great many directions, including the effect of the shadow on wireless transmission. There is little doubt that the full report will add to our knowledge very considerably.

The errors in the calculated times of beginning of totality, given in NATURE for January 31, were taken from the cabled reports in the *Observer* for January 25. They were very nearly correct, but need a little revision, which can now be made, thanks to a courteous communication from the editor of the *Scientific American* The observed times were late on the predicted ones as follows, Ithaca, 5 sec , Poughkeepsie, 2 7 sec ; New Haven, 4·7 sec , Easthampton, 5·5 sec , mean, 4·5 sec , practically identical with that given before The time at Buffalo was noted as 0 3 sec early, but uncertain owing to cloud

Easthampton, on Long Island, was occupied by a party despatched by the *Scientific American* It was at this station that five successful colour photographs of the corona were obtained by Mr Edward R. Hewitt, who has devised a very rapid process for such photographs

MOVING ABSORBING VAPOURS AT GREAT HEIGHTS ABOVE THE PHOTOSPHERE —Observations with the photographic recording spectrometer as employed by Deslandres in 1910 give the changes in appearance of a line emitted or absorbed by a chromospheric vapour and also its radial velocity Certain filaments are found to develop violent movements, after which they generally disappear or are much weakened. These phenomena are not observed with the spectroheliograph since its narrow second slit is adjusted for a line of the stationary vapour, and when this line is affected by the Doppler effect, it does not pass through it at all M. L d'Azambuja, in the *C R. Acad. Sci. Paris*, January 5, describes six cases which he has observed in the Meudon Observatory from April 1919 to January 1921, using the calcium K_3 line, four of which are similar to that described by Deslandres, and show radial, but no horizontal, movement The two others, however, show rapid and extensive horizontal movements, and in addition important radial ones Maps are given showing the forms and positions of these filaments at different times, together with the positions on the solar disc which they would have occupied had there been no horizontal movement. The filaments were seen at first on the spectroheliograms, but not when the radial velocity became large. The maximum velocity towards the observer of one of the filaments was about 25 km /sec , and it was estimated that it must have reached a height of 225,000 km , or about one-sixth of the solar diameter. No trace of it was left about an hour after it was last seen It is probable that the same phenomena are involved as in the formation of a temporary protuberance at the edge of the solar disc.

Research Items.

INDIAN ARCHÆOLOGY.—A "Note on Prehistoric Antiquities including Antiquities from Mohen-jo-daro" by Mr Ramaprasad Chanda, Superintendent of the Archæological Section of the Indian Museum, Calcutta, which was written for a visit to the Museum made by the Viceroy in December last, gives a valuable bird's-eye view of the archæology of India as illustrated by exhibits in the Museum. The specimens include palæoliths from the Deccan, the Central Indian Plateau, Rajputana, and Eastern India These approach most nearly to the Chellean and Acheulean types Typical neoliths have been collected from nearly all the provinces of India. Of the remains of the Copper Age, which followed the Neolithic in Northern and Central India, the most remarkable are the hoard from Gungeria, Central Provinces, consisting of 424 hammered copper implements and 102 thin silver plates, and a find of nine double axes from the Gulpha River in the Mayurbhanj State Antiquities found at Mohen-jo-daro and Harappe are now on loan in the Museum, among them being the seals with the unknown pictographic script, the pottery, and other objects which, it is suggested, show Sumerian affinities It is not generally known that three seals showing this pictographic script were discovered at Harappa in 1872 and in the 'eighties of the last century and were presented to the British Museum, where they are now exhibited

RACIAL CHARACTER.—An interesting question is raised in two papers published in the Proceedings of the American Philosophical Society, vol. 63, No 2, which discuss the question of potential equality in the various races of man In the first, Dr H N Hall maintains that if the test of history be applied to the negro race, and its past examined with the view of predicting its future, it appears that its mental disposition remains unchanged and seems unchangeable The argument is based upon a study of the culture of the negro and, in this instance, the divine or magical character of the kingship which in Africa, owing to the absence of social or political checks which elsewhere served as a counterbalance to the royal divinity, was incapable of useful development This was the result of a weakness of will in the negro mind which necessitated the support of a superior Dr Goldenweiser, on the other hand, argues that neither physically nor biologically are there any differences in the races of man which permit a grading into a progressive series from the animal upward, as, *e g*, in the case of hairiness, which is extreme in the Australian and European, but slight only in the Negro, Mongol, and American Indian; nor has psychology yet furnished any evidence to assist in grading, while the tests of culture, religion, and morality depend upon a bias determined by our own point of view

POLLINATION AND COMMERCIAL FRUIT GROWING.—Among the many factors that affect the good or bad cropping of fruit orchards, it has become recognised that self-sterility or self-fruitfulness plays a very considerable part Numerous experiments have shown that comparatively few varieties of the more important fruits are able to produce good crops unless they are cross-pollinated from another variety growing near by, and to this fact the poor cropping power of certain orchards is largely to be attributed. C H Hooper, in "Fruit Pollination in Relation to Commercial Fruit Growing" (Fruit Bull. 10, S.E. Agric Coll, Wye), sets out the analysed results of his own and many other records, the compiled lists affording definite guidance to fruit planters The smaller soft fruits all appear to be perfectly self-fruitful, but most need the agency of insects to effect cross-pollination from other plants of the same variety, strawberries being almost the only crop which is chiefly fertilised by wind. In the case of apple, pear, plum, and cherry, however, many varieties are unable to mature fruit with their own pollen, every orchard should thus contain at least two varieties flowering at approximately the same time and capable of cross-fertilisation. The difference between the earliest dates of flowering of varieties of the same fruit is considerable, averaging about twenty days for apples, twelve for pears, nineteen for plums, and three weeks or more for cherries The chief varieties are listed according to whether they are earliest, early, mid-season or late, and an indication is given of the degree to which each is self-sterile or self-fruitful In addition, examples are given of varieties that have been proved by experiment to fruit well together, and the recommendation is made that if trees of one variety only have been planted, about one tree in eight should be regrafted or replaced by another variety flowering about the same time. For apples, Bramley's seedling is suggested as a specially good variety with which to regraft The importance of insects in fruit pollination is emphasised, and bee-keeping is recommended for growers with large areas of a certain fruit Many other factors are recognised as influencing fruitfulness, but the question of imperfect fertilisation of the flower is less usually recognised, and is of sufficient importance to justify special attention being directed to its possible occurrence in cases of persistent poor cropping

THE PRACTICE OF ENSILAGE.—Silage has now become of considerable importance as a stock food, after a somewhat chequered history, and Amos (Journ Min. Agric. 31, Nos 8, 9, 11) outlines the present-day knowledge of the process of ensilage and the methods practised in Great Britain The quality of silage varies much with the conditions of manufacture, sweet, acid and green "fruity" silage all being recognised as desirable types, whereas sour and musty silage cause much loss, as stock often refuse to eat them Almost all herbaceous plants, with the exception of those of the cabbage tribe, can be made into silage, though all are not equally suitable. Tares and vetches, mixed with a supporting crop of oats, rye or beans, give most satisfactory results, providing silage of excellent food value, readily eaten by stock. In other parts of the world maize has proved of the greatest value for silage from every aspect, but as it is very sensitive to frost it is necessary, in Great Britain, to select special varieties bred and selected for habits of quick maturity, Saltger's North Dakota and Longfellow being recommended in place of the White Horse Tooth generally grown Sunflowers, rotation grasses, clovers and meadow grass can all be made into silage when occasion demands, but sunflower silage is less palatable than the others. A silage crop should be cut in a state of maturity rather more advanced than for haymaking, and second crops of seeds may be ensiled just after the corn harvest, maize being left to the last. The best silage results from a crop which is ensiled immediately after cutting, and careful organisation of labour is necessary to attain this end. Care is needed in filling the silo to obtain uniform shrinkage and to avoid undue spoiling and wastage in the upper layers Various methods are advocated to reduce this wastage, but none seem to be of real economic value, and a suitable cover for the top of a tower silo remains to be invented.

BIG BUD OF THE BLACK CURRANT.—We have referred on two occasions (NATURE, May 26, 1923, p. 719, and March 22, 1924, p. 439) to an experiment being conducted at the Crichton Royal Institution, Dumfries, on the eradication of big bud of the black currant, due to a mite. In 1922 the plot of 400 affected bushes was cut down and thoroughly fired The bushes made good growth and flowered in 1923, and again in 1924, but failed to fruit, and have shown marked indications of reversion Finally, last October, 60-80 per cent of the bushes showed re-infection by the mite (Annual Report for 1924, Crichton Royal Institution, Dumfries, p 23) The experiment, therefore, which gave much promise of success during the first year, has proved a failure, and the bushes have now been destroyed

THE CONTROL OF TSETSE FLIES.—In the *Bulletin of Entomological Research*, vol 15, Jan 1925, Dr. W A Lamborn gives an account of an interesting experiment which he has carried out in Nyasaland. In this instance an attempt has been made to ascertain whether it is possible to obtain some measure of control of the species of tsetse fly, *Glossina morsitans*, by artificially increasing the existing numbers of an apparently promising parasite in the fly area The parasite is the small chalcid *Syntomosphyrum glossinæ* Waterst which lays its eggs in the puparia of the Glossina The resulting larvæ devour the tissues of their hosts, thereby destroying them The chalcid is a favourable subject for the experiment, since it is a very prolific and rapid breeder, and is readily dealt with under artificial conditions It has the further advantage of being easily reared from puparia of flesh flies (Sarcophaga) and other Diptera A stock of this parasite was built up in the first instance from eleven females bred out from a single Glossina puparium These parasites were introduced to a number of Sarcophaga puparia, and the resulting chalcids were then utilised to parasitise a still larger number of the host Eventually, a large stock of parasitised puparia were deposited in the breeding places of the tsetse fly, so as to ensure that the emerging chalcids would be liberated in a favourable environment. It was estimated that, on an average, 67 examples of the Syntomosphyrum issue from each puparium, and that more than 277,000 parasites (mainly females) had emerged from the distributed examples Prior to the experiment the normal parasitisation of the Glossina in the area under consideration was found to be only 0·4-0 6 per cent In the year following the distribution, the parasitisation had risen to 8·7 per cent This result, although encouraging, is still a far step from having effected a degree of control of real practical value, nevertheless, it suggests that possibly a still larger output of the parasite might be worthy of trial.

OBSERVATIONS ON BRITISH COCCIDÆ.—Under this title Mr. E. E. Green publishes in the *Entomologist's Monthly Magazine* for February his ninth contribution of the series, on British scale-insects In the present paper four new species are described and figured, and among them *Kuwania pini* n.sp. is notable as providing the first record of a coccid occurring on pines in the British Isles. *Pseudococcus phalaridis* n.sp. from Frimley, Surrey, is recorded as being preyed upon by the larvæ of a fly which was identified by Mr. J. E. Collin as *Ochthiphila polystigma*. This enemy proved so efficient that, a little later on, the particular colony of the new species of coccid had been practically exterminated. Mr. Green suggests that this fly might possibly prove useful to check the ravages of the allied coccid, *Trionymus sacchari*, upon sugar-cane in Egypt and elsewhere. Among other scale-insects the occurrence of *Eriococcus hoheriæ* Mask. on *Hoheria populnea* in the Scilly Isles is of interest since it is the first record of this insect being found away from its original home (New Zealand). It has doubtlessly been imported with the plants from that country The many recent additions made to our knowledge of British scale-insects by Mr Green is but one example of how much work there still remains to be accomplished in working out the more obscure families of the British insect fauna

LIGIA NOVÆ-ZEALANDIÆ IN SOUTH AMERICA.—Prof C Chilton records (*New Zealand Journ Sci and Technol*, vi p 287, 1924) the occurrence at Valparaiso of the shore isopod, *Ligia novæ-zealandiæ*, a species which is found also in New Zealand and Juan Fernandez These isopods carry their eggs in brood pouches under the body until the young are hatched in a form resembling the adult, and hence it is unlikely that they could cross large tracts of ocean The existence of this species in the three places referred to is held to be additional evidence in support of a former land connexion between them The shore amphipod, *Orchestia chilensis*, which lives under similar conditions to the Ligia, is also found on the shores of Chile, Juan Fernandez, and New Zealand

THE DEVELOPMENT OF THE MALE GENITALIA OF HOMOPTERA.—An extensive literature has grown up around the subject of the structure and homologies of the male genitalia of insects The nomenclature of the different parts is highly involved and it is often extremely difficult to trace their homologies in different orders In the *Quarterly Journal of Microscopical Science*, vol 69, part 1, Dec 1924, Dr Hem Singh-Pruthi has an important contribution to this subject with particular reference to the Homoptera In these insects he finds that the male genitalia consist of two pairs of lateral appendages, the sub-genital plates and the parameres, and a median copulatory organ, the ædeagus They are all borne by the ninth abdominal segment They develop from two pairs of appendages only, an outer and an inner, which appear as diverticula of the ventral region of the ninth segment The outer pair develops into the sub-genital plates, and the inner by longitudinal fission becomes two pairs, the inner one of the two pairs so obtained, by the fusion along the median line of its components, forms a single organ, the ædeagus, while the outer is transformed into the parameres Thus the pair of appendages developing into the sub-genital plates does not belong to the eighth segment, as was believed by Kershaw and Muir, but to the ninth, there are no appendages on the eighth in the nymphs or in the adult, nor is there any evidence in favour of these authors' view that the male gonopore in Homoptera, unlike that in most orders of insects, lies between the eighth and ninth sterna, it is in its usual place, behind the ninth sternum The sub-genital plates seem to be the coxites of the ninth sternum; and both the ædeagus and the parameres, derived from a primitively single pair of appendages, correspond to the endopodites

METEOR CRATER, ARIZONA.—A letter to the *Engineering and Mining Journal-Press* for February 7, from Mr L F S Holland, superintendent with the Company the recent drilling operations of which under the rim of Meteor Crater have aroused widespread interest, prompts us to refer once more to the origin of this puzzling "crater" (see NATURE, February 14, p. 244). Mr Holland is chiefly concerned in correcting the many false impressions that have been spread abroad by enthusiastic but largely misleading journalism He confirms the presence of platinum in the

iron meteorites of the neighbourhood, giving the average as one ounce of platinum to five tons of meteorite. An American Sunday paper has published a photograph of an apparently large diamond alleged to have been embedded in an Arizona meteorite Possibly the magnification was not stated, but the truth of the matter is that, while diamonds do occur, they are invariably of microscopic dimensions Of more importance is Mr. Holland's belief that the crater can be best explained by the impact of a shower of meteorites. However, he doubts whether the recent boring went far enough to prove or disprove Barringer's latest theory that the main mass of the meteoric shower became embedded under the southern rim at an angle with the surrounding plain.

THE PETROLOGY OF PENMAENMAWR.—The differentiation of the magma which is now represented by the interesting intrusion of Penmaenmawr is discussed by H. C. Sargent in a recent paper (Proc Liverpool Geol Soc vol xiv, 1924, pp. 82-98) which supplements his earlier work on the various rock-types. Below the 1000-foot contour the rock is a very fresh enstatite-porphyrite with labradorite as the dominant mineral Above this level the plagioclase becomes less calcic, gradually reaching oligoclase, while quartz and orthoclase, mainly present as micropegmatite, steadily increase upwards The author ascribes the differentiation to the inhibition of reaction between the earlier-formed crystals and the residual liquid (shown by the existence of zoned felspars), accompanied by the straining-off of the more siliceous and alkaline material in which the volatile constituents would also be concentrated. He considers it is not safe to assume that sinking of crystals has been an important process, as the grain-size shows no marked variation with height. But the process outlined would not provide an upper concentration of quartz and orthoclase unless the other minerals became concentrated downwards, so that relative movement of crystals and residual liquid is logically implied The influence of volatile fluxes is shown by the increasing turbidity of the felspars as they are traced upwards, by the production of bastite, epidote, and other alteration-products, and by the scarcity of biotite in the higher horizons. It is clearly pointed out that these features cannot be due to weathering In the upper part of the adjoining Craig Lwyd area hornblende is abundant, but so far no explanation is forthcoming to explain this mineralogical difference There seems to be a lateral as well as a vertical differentiation, the south-eastern portion being richer in lime and the north-western richer in potash, thus suggesting that the intrusion may have come from the south-east. Part II. of the paper, not yet published, may throw further light on these speculations.

THE AGES OF RADIOACTIVE MINERALS.—The measurement of geological time by methods based on the decay of radioactive substances is now receiving renewed attention in the United States. The National Research Council has appointed a committee under the chairmanship of Prof. A. C. Lane, to investigate the subject, and the committee has performed a valuable preliminary service by issuing a bibliography of the literature by R. C. Wells. In Canada the Geological Survey has assigned to H. V. Ellsworth the task of applying the methods to Canadian problems. A first paper from his pen is now published in the *American Journal of Science* for February 1925, and gives the results of several new analyses, and a valuable discussion of the principles involved. Hitherto it has been found that when thorium is a noteworthy constituent of a series of minerals, the lead-ratios derived from them are too variable to be trusted, and the tendency has therefore been to ignore such minerals in the expectation that sooner or later the discrepancies associated with thorium would be explained. This course has been followed without detriment to the development of the subject, since for uranium minerals in which thorium was not an important constituent the results have been concordant among themselves and with the geological evidence. Ellsworth, however, in calculating the ages of a series of uraninites from the pegmatites of Ontario, has taken thorium fully into consideration with results that are a little more consistent than they would have been had thorium been ignored The ages vary from 1115 to 1189 million years, with an outside figure based on considerably altered material of 1299 million years These values agree very closely with those obtained from minerals of Middle pre-Cambrian age occurring in Scandinavia, Africa, India, and the United States Before any further advance can be made, apart from the accumulation of analyses, it is essential that the half-periods of thorium and uranium should be re-investigated in relation to the possibility of isotopes of the parent elements, and that the genetic connexion of thorium and uranium, if there be one, or has been one, should be disentangled from the conflicting evidence.

VELOCITY OF DIFFUSION, VISCOSITY, AND EXTERNAL PRESSURE.—Messrs. E. Cohen and H. R. Bruins describe, in the *Zeitschrift für physikalische Chemie*, January 20, a new apparatus for determining the viscosity of mercury at high pressures. The ratio of the viscosity at 1500 atmospheres pressure to that at one atmosphere is found to be 1·048, at temperature 20° C In their previous investigation into the effect of pressure on the velocity of diffusion of cadmium in mercury, at the above temperature, it was found that the ratio of the velocity of diffusion at one atmosphere to that at 1500 atmospheres is 1·051. It follows then that, within the limits of accuracy of the diffusion measurements, the product of the viscosity and velocity of diffusion is the same at one and at 1500 atmospheres. This agrees with the results of previous investigations of the authors, which showed that the velocity of diffusion at atmospheric pressure was inversely proportional to the viscosity, even when the molecules of the diffusing substance and of the medium into which diffusion took place were of equal size.

STARK EFFECT IN METALLIC ARCS.—In the *Japanese Journal of Physics*, vol. 3, p. 45, H. Nagaoka and Y. Sugiura describe an investigation of the Stark effect produced in the electric arc for a number of metals. It was first necessary to stabilise the arc, and this was done by introducing a capacity of more than one microfarad and a large self-inductance between the electrodes, and using a P.D. of 500 volts obtained from a direct current generator. By employing carbon as the cathode and the metal under test as the anode, arcs of 7 cm. in length were maintained with perfect steadiness. The potential changes along the arc were examined, and the electrodes were found to be the seats of strong electric fields due to the presence of an electric double layer which is formed when the current surpasses a critical value. Using a small drop of metal at the anode, fields of the order of 10^6 volts per cm. were obtained, and the Stark effects in these fields were studied. It was found that, with several metals, lines belonging to the same spectrum series were similarly affected, the nature of the change being different for different series, and that the effect increased with the term number.

Mining Research.

THE Executive Board of Mining Research of the University of Birmingham has just issued a report on the work of the Mining Research Laboratory for the years 1921-1924, the report being signed by Dr. J. S. Haldane, who is the chairman of this Board. The report gives an interesting summary of the various researches which are being undertaken, some of which deal with problems of very great importance to the coal industry. Necessarily some of these researches are purely scientific, whilst others are essentially practical, but it is quite obvious that the results of even the first named are likely to find important practical applications. A great deal of work has been done upon the absorption of various gases by coal, and the effect that these phenomena may have upon the spontaneous combustion of coal has been carefully investigated. A certain amount of work has been done on the application of wireless electricity to underground problems, but no definite conclusions appear to have been reached, and the work has, for the present at any rate, been laid aside. A most interesting group of physiological experiments has been carried out by means of an experimental chamber by which it is possible to test the effect of various gases upon men at rest and at work, as the result of these experiments, accurate information as to the effect of carbon monoxide upon those exposed to its influence has been rendered available, and it has been shown that this poisonous gas is absorbed far more readily by men doing work than when they are at rest. Another series of these experiments has tested the suggested new method of treatment for carbon monoxide poisoning as well as for asphyxiation, the value of carbon dioxide for this purpose having been shown by these researches, with which the name of Dr. Haldane is closely associated

Another set of researches, the ultimate results of which may be of very far-reaching importance, are those upon the discoveries of Dr. Bergius dealing with the hydrogenation of coal. It has been found that when coal is mixed with a suitable liquid such as phenol, and heated to approximately 400° C in an atmosphere of hydrogen under a pressure of 155 atmospheres for a considerable length of time, hydrogen is absorbed and a quantity of coal, in some cases up to 40 per cent., is converted into an oil-like liquid. The various constituents of coal have been tested, and it is found that clarain and durain are hydrogenated with comparative facility, but that fusain is very little affected. The possibility of hydrogenating coal under these conditions has thus been definitely confirmed, and substantial yields of liquid products have been obtained, though the nature of these liquids has not yet been fully investigated; it is stated that they appear to contain oxygen, and that it is a question yet to be determined whether it is possible to eliminate this oxygen by further hydrogenation and thus to obtain hydrocarbons. Attention is directed to the fact that the behaviour of clarain and durain is approximately the same, and that the liquids obtained by treating these constituents give almost identical analytical results, and it is suggested that this fact would appear to support Prof. Wheeler's contention that clarain and durain contain constituents of similar chemical type. Although up to the present the results obtained by the hydrogenation of coal have a purely scientific interest, it must be remembered that they only represent the initial stages of a very complex investigation, and that it is quite possible that the ultimate outcome of this may produce results of the utmost economic importance.

Researches on the spontaneous combustion of coal have occupied a considerable portion of the work of the Mining Research Laboratory. It will be remembered by those interested that the Mining Research Laboratory of the University of Birmingham was established to continue the work originally started in the Doncaster Research Laboratory, which was established with the definite object of investigating spontaneous fires in the collieries of that district. It is, however, only proper to point out that whilst the investigation was due in the first instance to the necessity for combating the dangers to which the coal of the district was especially liable, the Doncaster Coal Owners' Committee from the outset placed all its laboratory results freely and fully at the disposal of the entire coal mining industry, and took care to publish all the results obtained by its laboratory staff. This work has been continued at Birmingham, and the oxidisability of different types of coal has been recently studied, as also has the liability of the various constituents of coal to spontaneous combustion. The results have clearly shown that fusain is relatively insensible chemically, and that its oxidation is negligible as a source of heat in initiating spontaneous combustion On the other hand, it is pointed out that bands of fusain, on account of their open physical structure, may play an important part in aiding spontaneous combustion by forming channels through which supplies of air can readily reach the more oxidisable constituents of the coal.

A number of researches, all bearing on the investigation of the oxidation of coal, are being carried on, and it is worth noting that they are being assisted by a grant from the Miners' Welfare Fund, made on the recommendation of the Safety in Mines Research Board of the Mines Department. It is, of course, of the greatest importance to the industry that all the mining research now carried on throughout Great Britain should be co-ordinated by a central authority, not with the view of controlling the work, but mainly to see that no excessive overlapping occurs and to take care that provision may be made for filling up any important gaps in our knowledge which may be left between a number of individual lines of research. It is interesting to note that a number of respirators, most of which have originated in the United States, and are designed to enable men to live for a certain time in an atmosphere of carbonic oxide by oxidising this gas to the relatively innocuous carbonic acid, have been examined, and the results are now being published in the Transactions of the Institution of Mining Engineers.

Finally, we have a group of researches conducted in order to determine the effect of specially hot and deep mines, this work now being carried out in conjunction with a committee of the Institution of Mining Engineers, financed by grants from the Department of Scientific and Industrial Research and the Miners' Welfare Committee on the recommendation of the Safety in Mines Research Board of the Mines Department. Nine reports have already been published as communications to the Institution of Mining Engineers, a form in which they are conveniently available for men engaged in mining operations in all parts of the world The work is being continued, and there is still a large field open for research

It will be obvious from this brief summary of the report that the Mining Research Laboratory of the University of Birmingham is doing work of the utmost value to the mining industry; by far the greater part of this work bears directly upon the safety, health, and welfare of men engaged in the coal mining industry.

Diagnosis of Ankylostomiasis.

THE publication before us[1] aims at giving a connected account of copious and careful work already published in the *Indian Journal of Medical Research*, and since in certain instances it is only the conclusions originally drawn which are now reproduced, their validity cannot be estimated except by reference to the original record

Since all scientific work on ankylostomiasis must rest on accurate diagnosis, great attention is paid to the direct methods by which this is obtainable, namely, to detection of ova and collecting of worms The former was undertaken mainly by microscopic examination of the centrifugal deposit from a strained fæcal suspension, but partly by a special modification of the commonly used concentrative principle inherent in the employment of a heavy salt solution in which hookworm ova float and other fæcal matter sinks.

For the particular floatation technique described, it is claimed that it loses only 7 per cent of ova as against a loss of 50 per cent. or more entailed by other methods, the control employed being apparently the first-mentioned technique Regarding the control, Mhaskar himself finds it inaccurate in that, in the one instance noted, subsequent floating of a counted smear increased the countable ova by 14 per cent The extraordinary inadequacy of these controlling counts is, however, shown by the reviewer's figures, hitherto undisputed, indicating that the average addition required to this particular form of control is not 14 but more than 30 per cent. He finds, too (the report is now in the press), that in his hands Mhaskar's floatation technique indicates an ovum content from one-tenth to one-sixth of that which another, namely, direct centrifugal floatation, shows to be certainly present

It is of interest to refer here to a compilation by Dr. Khalil,[2] who advocates a technique embodying yet another modification of the floatation principle, a saturated solution of common salt being used to float up ova in the inverted cone formed by an Erlenmeyer flask, coarse fæcal matter having first been strained off through a fine sieve. Clearly the intention is that the rising hookworm eggs should become concentrated upon a small area, their removal to a small examination area being thus facilitated. The technique is held to ensure detection of mild infections. It is entirely uncontrolled.

Now the only recorded effort hitherto made (by the present reviewer) to control the effects of floatation in an inverted cone showed that the number of ova recovered from the surface was, on the average, one-tenth of those which a control count indicated as present in the fæces employed, and it has since been shown, as noted above, that that particular control underestimated the ovum content by an average of more than 30 per cent It is not then possible, without evidence offered of the ovum content of the fæces used, to accept as accurate this new gravity floatation method in an inverted cone Presumption of its inaccuracy lies in the many instances here reported where it detected a solitary ovum, whereas, as the available evidence suggests, there were indeed present some twenty or thirty, detectable by adequate means, and in the fact that while 40,000 examinations by the admittedly inadequate smear or centrifugal precipitation methods showed an infection percentage in different parts of lower Egypt of 48 to 97, that obtained in the one village tested by the new technique was only 16·6.

The particular importance of accurate and controlled examinations in Egypt lies in its being apparently the only country in the world where extensive human hookworm infection is limited to *Ancylostoma duodenale* It offers, therefore, unique opportunities for determining whether, as, for example, in ovum output and reaction to treatment, ancylostomiasis and necatoriasis differ—whether there be one ankylostomiasis or two.

Regarding diagnosis by collecting the worms passed after the administration of an anthelmintic, Mhaskar failed to find males in a tenth of cases which were passing fertile eggs, and females in 71·6 per cent. of 500 cases, also passing fertile eggs His conclusion that intensity of infection cannot be gauged by the number of ova found on a slide, though inevitable on his premises, is not necessarily correct.

It is further concluded, without qualification, that betanaphthol thymol and carbon tetrachloride have a fleeting effect on oviposition, their administration rendering diagnosis by search for ova untrustworthy for four days. But the original table, if analysed, shows that in 227 cases treated, 129, or 57 per cent, were not cured, and of the uncured 18, or 14 per cent. only, showed this temporary inability of the diagnostic method employed to detect ova On the other hand, of the 98 cases reasonably presumed cured (for ova were not found in their stools after the third day) 48, or 51 per cent, showed ova during one or more of the first three days. Clearly all factors have not been considered in drawing these conclusions.

The line of treatment used for tea estate labour illustrates vividly the features of the procedure at present fashionable. In one group of estates there was instituted the popular mass treatment without diagnosis. Betanaphthol was administered by scooping it up in a measured spoon It was concluded that as regards 50 grain doses for an adult "it is safe, and even a mistake in excess of the maximum dosage advised is not followed by any serious inconvenience; not much care is required in prescribing this drug, nor is any after-supervision necessary" There is no cross reference under this comment to the following incident On the next set of tea estates, examination of 104 fæcal specimens showed 94 infected Mass treatment was accordingly administered without further diagnostic examinations. Of 1400 persons treated as described with betanaphthol, 2 died and 37 became gravely ill, with the symptoms of poisoning already described in the *Indian Medical Gazette* by Orme and by Corteling, and for Brazil by Smillie. Two men, that is, died of poisoning by a drug administered for an infestation, of their individual possession of which there is no evidence. The betanaphthol was proved to be chemically pure.

In the matter of prevention, which is of course summed up in the word soil-infection, it is shown that larvæ identified as those of hookworms persisted in trenched nightsoil for 13 to 14 weeks, and in the surrounding soil for 6 to 9 weeks; but it is concluded that larvæ do not migrate from the place of development. Larvæ found in the soil after 16 weeks were held in all cases to be non-parasitic, for it is stated that, apparently in some 14 experiments, counted numbers of these larvæ were placed in a drop of water left lying on the skin of the forearm for half an hour, and that every one of these larvæ was afterwards pipetted off and accounted for.

The valuable work here detailed merits close examination, however much one may feel compelled to dissent from the main conclusions.

CLAYTON LANE.

[1] Report of the Ankylostomiasis Inquiry in Madras. By K. H. Mhaskar. Indian Medical Research Memoirs, Volume No 1 October 1924.

[2] Ankylostomiasis and Bilharziasis in Egypt Reports and Notes of the Public Health Laboratories, Cairo, No 6. 30 P T.

University and Educational Intelligence.

CAMBRIDGE.—The report of the Appointments Board for the year 1924 presents interesting reading The number of appointments found for graduates of the University has increased to 400. The chief groups are educational appointments, 123; manufacturing and technical appointments, 103, administrative appointments in commerce and industry, 90; agriculture and forestry, 25, and colonial administration, 16. The board notes a dearth of candidates for the great public services overseas.

The annual report of the General Board of Studies on the progress and condition of certain University departments for the year 1923-24 refers to a number of facts already noted in these columns. A general slight decrease in the number of students in the scientific departments is noted. Sir Frederick Gowland Hopkins points out that the amount available for research from the Dunn Bequest, 2400*l* per annum, did not suffice to meet the needs of his 40 research workers and that the maintenance of research on this scale had involved his department in financial difficulties. Prof. Seward reports his inability to find money for the stipend of the curator of the Botanical Museum. Prof. Inglis reports that arrangements have been completed for the course for officers of the Royal Engineers to be extended to two years so that these officers would take the Mechanical Sciences Tripos Prof Dean emphasises the value in the teaching of pathology of its recognition as a subject in Part II of the Natural Sciences Tripos. It has brought the subject from the pass standard of the medical curriculum to the honours standard of the Tripos. Increased accommodation has led to much improvement in the arrangements of the Museum of Zoology, especially in the case of the entomological collections.

Sir Humphry Davy Rolleston, Bt., president of the Royal College of Physicians, has been appointed Regius professor of physic in succession to the Right Hon. Sir Thomas Clifford Allbutt

EDINBURGH.—At the meeting of the University Court on March 16, intimation was made that His Majesty, on the advice of the Secretary for Scotland, had appointed Dr. John Fraser to be Regius professor of clinical surgery in succession to Sir Harold Stiles, who resigned on March 20.

Leave of absence for May and June was granted to the professor of materia medica to enable him to deliver the Dohme Memorial Lectures at Johns Hopkins University, Baltimore. Prof. Cushny proposes to deal in these lectures with the subject of optical isomers in biology.

The Munro Lectures on anthropology and prehistoric archæology will be delivered by Sir Arthur Keith in May next.

Mr. K. G. Fenelon, lecturer in economics, was appointed in connexion with the educational courses for railway staffs to deliver the course of lectures for 1925–26, the subject being railway economics.

A letter was received from the Forestry Commission stating that the Commissioners had had under consideration the question of mycology in relation to forestry work, that they regarded it as a matter of urgency that a means should be found to combat fungoid diseases, which were causing the department serious loss in its nurseries and young plantations, and that they were prepared to make to the University in respect of the year commencing April 1 next a grant not exceeding 500*l*. for research in this connexion to be carried out by the Botanical Department of the University. The Court welcomed the proposal and concurred in the arrangements suggested.

LONDON.—Keddey Fletcher-Warr Studentships, each of the value of 200*l*. a year for three years, have been awarded to Mr D C Harrison (King's College), for research in biochemistry, and to Dr N A. V. Piercy (East London College), for research in aeronautics.

ST ANDREWS.—At a meeting of the University Court on Friday, March 20, Mr. William W McClelland, principal lecturer in education in Edinburgh Training Centre and lecturer in the University of Edinburgh, was appointed to the Bell chair of education, the duties of the chair embracing the University lectures in education at St. Andrews and Dundee Prof. McClelland will also act as Director of the St Andrews Provincial Committee for the Training of Teachers

Prof. A E. Taylor, formerly professor of moral philosophy at St Andrews, now occupying the chair of moral philosophy at Edinburgh, has been appointed to deliver the Gifford Lectures in the session 1926–1927

THE governing body of the Northampton Polytechnic Institute, St. John Street, Clerkenwell, E C 1, is inviting applications for the headship of the electrical engineering department. Particulars of the appointment and forms of application are obtainable from the principal Completed forms must be returned by April 18 at latest

A SENIOR lecturer in dental anatomy, physiology, and histology will shortly be appointed by the University of the Witwatersrand, Johannesburg Particulars and forms of application may be had from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W C 2. Completed forms and testimonials (in each case three in number) must be sent in by April 11 at latest

A REPORT on facilities for advanced study and research in the universities and university colleges of England and Wales is published in the March number of the *University Bulletin*, the organ of the Association of University Teachers The report is the work of a committee comprising the Principal of the University of St. Andrews and nine professors of the Universities of Oxford, Cambridge, London, Leeds, Liverpool, Sheffield, and Bristol, the Imperial College of Science and the University College of Wales The committee adduces the usual reasons for the improvement of salaries, the lightening of the teachers' load of routine work, and the granting of special leave of absence for the purpose of pursuing an investigation or completing a piece of original work, and states that no teacher should be expected to give more than half his working day to routine University duties It is suggested that in each territorial region a joint body representing the University and the secondary schools of that region might with advantage be set up for the purposes of such co-ordination of curricula and adjustment of university entrance requirements as would tend to free the universities for their proper work The institution of research professorships is regarded with disfavour by all the local branches of the association, and the committee agrees that it is not to be recommended as a general policy though useful in special circumstances Special attention is directed to the policy adopted by the University of Birmingham of maintaining a research fund administered by a joint standing committee. The same number of the *Bulletin* contains articles on library co-operation, examinations, the University of London, and income tax on salary earned abroad—showing that this journal no longer confines itself mainly to recording the activities of the Association of University Teachers.

Early Science at Oxford.

March 30, 1686. Dr. Plot communicated coal from Amrath in Pembrokeshire, which being spit on gave an Ink for writing, as was found true by experiment before ye Society

March 31, 1685. Mr. President was pleased to give the Society a more full account of his extracting the Root of a Number of 53 places in the darke, by the help of Memory

Upon occasion of a Discourse at a meeting of the Philosophicall Society at Oxford (March 24, 1684–5) concerning the advantage, which those may have (as to Memory, & the application thereof) who want their sight, Dr Wallis confirmed it by this consideration, that even we, that have our eye-sight, can yet with more advantage apply our Memory (in matters of intent consideration) by night, in the dark, when all things are quiet, than by day, when sights and noises are apt to divert our thoughts: And gave instance in his application of his own memory, by night, (in performing Arithmeticall operations in great numbers) better, than by day he could have done: and, even by day, we may better do it with our eyes shut, than open

Having had the curiosity heretofore to try, how far ye strength of Memory would suffice me to performe some Arithmeticall Operations (as Multiplication, Division, Extraction of Roots &c) without the assistance of Pen, & Ink, or ought equivalent thereunto, And finding it to succeed well for instance in extracting the Square Root from numbers of 8, 10, 12, or more places: I proceeded to try it (with successe) in numbers of 20, 30, or 40 places On December ye 22d, 1669, I had (by night, in the darke) extracted the Square Root of 3 (with cyphers adjoyn'd) continued to ye twentieth place of Decimall Fractions. I did that same night (by darke, in bed, without any other assistance, than my memory) propose to my self (at all adventures) this Number of 53 places

2,4681, 3579, 1012, 1411, 1315, 1618, 2017, 1921, 2224, 2628, 3023, 2527, 2931,

and found its Square Root of 27 places to be

157, 1030, 1687, 1482, 8058, 1715, 2171 ferè

These numbers (having fixed them in my Memory, by repeating the same operation a night or two after) when a friend made me another visit, March 11th following, I did dictate to him from my memory (having not before committed them to writing) for him to write down and examine And did afterwards write them down myself

April 3, 1688. Mr Walker shewed the Society some drop Microscopes, and the manner of makeing them

Mr. Charlet acquainted the Society of a Cock with three legs, and two anus's at William Greenhill's Esqr at Abbots Langley near St Albans.

Several formed Stones were shewed the Society viz *Cornua Ammonis, Mytiloides, Solenites, Conchites;* several Stones called St. Cuthbert-beads, and other stones exactly of the figure of a Cocks Spur, which, as Dr Plot related, are only the pointes of those Stones called St Cuthbert-beads, most of which were found in the Quarries on the side of Wotton-under-hedg-Hill in Glocestershire, as also a great hollow mass of Iron Oar, brought from St Vincents Rocks near Bristol, which in the concave was beset with hexangular crystalls; as also some masses of Lead Oar Oar found on Lye-Down near Bristoll, from which it is said they extract Silver in a Cup alle standing under the aforesaid Down

Upon the sight of which the President acquainted the Society that at Stanton-Prior *Cornua Ammonis* were the natural stones of ye place

Societies and Academies.

LONDON.

Royal Society, March 19.—Sir William **Hardy** and Ida **Bircumshaw**: Boundary lubrication: plane surfaces and the limitations of Amontons' law (Bakerian Lecture). When the slider has a plane face the coefficient of friction is a function of the load, decreasing as the load increases, until a point is reached beyond which the coefficient is independent of the load When it has a spherical face, the coefficient is always independent of the load The coefficient is a measure of the efficiency of the lubricating layer with respect to one variable—the load Recollecting that the pressure between the bearing surfaces must be very great when the slider has a spherical face, the above results show that with low pressure the efficiency of the lubricant increases as the pressure increases until a limit is reached, beyond which Amontons' law holds It is probable that, during the first period, when Amontons' law does not hold, the slider is floating on a layer of lubricant the thickness of which is a function of the pressure, whilst in the second period, where Amontons' law holds, all lubricant which can be squeezed out has been squeezed out, and a layer of constant molecular composition has been reached In the first period friction is adjusted to the load by variations in the thickness of the layer of lubricant, and in the second period by the elastic forces between the atoms.

Linnean Society, February 5.—G P. **Bidder**: Growth and death A water-borne organism may grow indefinitely, but swiftly moving land-animals must maintain a relation between their weight and the cross-sectional area of their bones and muscles Men and plaice before puberty alike show additions to their weight in approximately geometrical progression for equal intervals of time, alike after sexual maturity they show an approximately arithmetical progression In the plaice the annual increment remains to a great age positive. In man the arithmetical progression shows a difference with negative sign, and from 28 (the age of greatest reproductive fertility) onwards there appears to be a constant net loss of protein material, amounting annually to $(0{\cdot}8 \pm 0{\cdot}15)$ per cent. of its weight at 28. The mechanism of the adult body is set after sexual maturity to a certain annual balance of profit and loss for water-borne animals this may be a positive increment and life may be eternal; for terrestrial animals the length of life depends on the nearness to equality of profit and loss. A positive annual increment, however small, will eventually bring about death from gigantism; it is not improbable that this has been, and possibly is now, the form of death in some quadrupeds. A negative annual increment, however small, determines a date at which all capital resources will disappear. We die, therefore, as an alternative to becoming giants.

Faraday Society, February 16.—A J. **Allmand** and V. S. **Puri**: The effect of superposed alternating current on the anodic solution of gold in hydrochloric acid. The only well-known case in which a superposed alternating current is used in technical electrolysis is furnished by the Wohlwill modified gold refining process. Pure gold anodes in hydrochloric acid solution were employed, using direct current alone, and also the same with alternating current superposed. Anode potentials have been measured throughout.—C. H. **Desch** and Eileen M. **Vellan**: The electrolytic deposition of cadmium and other metals on aluminium. Where lightness is of importance, as

in aeronautical work, the deposit should be thin, and the choice of metals is further limited by the tendency of many deposits to detach themselves. Preliminary experiments having shown that cadmium was better in these respects than copper or nickel, an investigation into the best conditions of deposition was undertaken. Other methods of protection are on the whole more useful, but comparison with other metallic coatings shows a great superiority in favour of cadmium, even under the severe test of exposure to a salt spray. The deposit has a pleasing appearance and a good colour.—W. M. **Thornton** and J. A **Harle**: The electrolytic corrosion of ferrous metals The most direct way of subjecting a metal to the influence of active moist gas is by electrolysis Since rust is almost entirely oxide, it is only necessary to make the specimen the anode of a cell containing slightly acidulated water in order to obtain conditions of exposure to moist oxygen which are perfectly under control. Not only have pure metals definite rates of corrosion according to Faraday's laws, but also every ferrous alloy examined has a specific rate of electrolytic corrosion by which it can be identified with certainty. This may prove a basis for a systematic comparison of the behaviour of ferrous alloys under all conditions of exposure which result in oxidation.—S. **Glasstone** Overvoltage and surface forces at the lead cathode. The addition of ethyl or methyl alcohol, or acetic acid, to aqueous solutions with various hydrogen ion concentrations lowers the surface tension and also the overvoltage Substances like iso-amyl alcohol, which are sparingly soluble in water and lower its surface tension considerably, cause the overvoltage of a lead cathode first to increase and then to decrease as increasing amounts are added. A complete theory of overvoltage must take into account the surface forces involved in bubble formation.—M **Shikata**. The electrolysis of nitrobenzene with the mercury-dropping cathode Part I The reduction potential of nitrobenzene Nernst's formula, modified by the adsorption isotherm, was verified in acid and alkaline solutions An abnormal reduction potential in alkaline solution was found and "neutral salt actions" were observed The reduction due to the simple deposition of hydrions, and to the ionic splitting of water in neutral solutions, was distinguished by the current-voltage curves Part II The influence of the cathodic potential on the adsorption of nitrobenzene A maximum reduction current followed by a minimum, due to certain potentials, were observed in the reduction of nitrobenzene. The formation of a maximum reduction current was explained by the de-sorption due to the applied polarisation potential of the mercury drops Observed influences of neutral salts upon the R.P. and on adsorption were explained by the "salting-out" action. The method is applicable to quantitative and qualitative micro-analysis.—J R. H. **Coutts**: The law of distribution of particles in colloidal suspensions. a note on the specific volume of a gamboge suspension. Measurements of the specific volume of a dilute gamboge suspension, to an accuracy of about 1 in 60,000, verified the assumption made by Porter and Hedges, namely, that no significant contraction or expansion takes place in the formation of such a suspension.—W. W. **Barkas**: On the distribution of particles in colloidal suspensions. The results of measurements made in centrifuged solutions of gamboge, silver and copper, of the sizes of particles given by the formula of Porter and Hedges as compared with the sizes given by the law of centrifuging developed by E. Talbot Paris, are discussed. The same values of the radius are given for copper by the two methods; for silver the radius from the distribution is higher, and for gamboge lower than from the centrifuge. The radius given from the distribution of uncentrifuged solutions is in similar agreement with that given from the rate of fall of the cloud particles by Stokes's Law. If the solution under examination could be effectively shielded from changes in temperature, the determination of the distribution would give an accurate measure of the mean size of the particles in a solution, provided their density was known Over a considerable range of concentrations, the level at which the distribution is sensibly uniform is quickly reached and the limiting concentration is directly proportional to the number of particles present in the solution

Royal Statistical Society, February 17.—E S **Russell** and T **Edser**: The fishery statistics of England and Wales. The number of fishermen engaged in the sea industry is about 40,000, and all the waters of the continental slope, from the Barents Sea down to the Atlantic coast of Morocco, are visited by English trawlers in their search for fish, and to the north-westward the waters round Iceland and Faroe are regularly frequented. The value in 1923 of the catch of bottom-living or demersal fish, the great bulk of which is brought in by steam trawlers, was 12,500,000*l*. To this must be added the value of a catch of pelagic or surface-living fish caught mainly by drift nets, which amounted in 1923 to 1,500,000*l*. The principal pelagic fish is the herring, of which more than 3,000,000 cwt was landed in 1923 Statistics of real value date back to 1886, and marked improvements were made in 1903 and 1906 It is now possible to allot catches to rectangular areas of 1° of longitude by 1° of latitude, and the catch per 100 hours' fishing can be worked out for steam trawlers and certain other classes of vessels An international system of groups of these rectangular areas has been evolved and is accepted by the nations adhering to the International Council for the Exploration of the Sea

Royal Meteorological Society, February 18.—Miss L D **Sawyer** The effect of pressure distribution upon London's sunshine in winter The results were based on an analysis of the pressure types during the five winters ending 1921-22, and the amount of sunshine recorded in different parts of London each day Near the centre of a depression the average sunshine is less than 0·5 h per day, and near the centre of an anticyclone the figures are equally poor except with E S E. breezes If the pressure centre is at least two or three hundred miles away, the average with anticyclonic conditions is about two and a half times as great as with cyclonic, while a "neutral distribution" (neither cyclonic nor anticyclonic) is almost as sunny Records show that Hampstead and Greenwich are both almost as sunny as South Farnborough when the air reaches them before passing over London, but Hampstead loses more than an hour a day with S E winds and Greenwich as much or more with N.W. winds.—S. **Chapman**: On the changes of temperature in the lower atmosphere, by eddy conduction and otherwise. For a number of years hourly observations of the temperature of the air have been made on the Eiffel Tower, at the base, the top, and two intermediate heights, *i.e* of the change of temperature in the lowest stratum of the atmosphere, 300 metres, or nearly 1000 ft thick Eddy conduction is not the predominant cause of the temperature changes, and the effect of the remaining (major) cause, probably radiation, is far from being constant with respect to height. The temperature changes wrought by conduction are greatest at midday and small at night; those produced by radiation are greatest soon after dawn (when the air is being heated rapidly) and

in the late afternoon (when the air is cooling).—N. K. **Johnson** and O. F. T. **Roberts**: The measurement of the lapse rate by an optical method. Theoretical expressions have been deduced by various authors connecting the apparent vertical displacement of a horizontal ray with the length of the ray path and the vertical gradient of temperature in the atmosphere. The results of the observations confirm the theory within the limits of accuracy of the measurements. With certain limitations, the optical method affords a practical means of determining the vertical gradient of temperature.

Geological Society, February 20.—J. W **Evans** Regions of tension, evidenced by joints, slip-faults, and dykes (Anniversary Address) The different causes of local tension were given, including torsion; but although the latter was found by Daubrée to give systems of fractures at right angles to one another, these might also be produced in any area with maximum and minimum directions of tension Western Europe is largely characterised by tension towards the south-west, but north-westward tension prevailed in north-western Ireland and north-western Scotland The south-westward tension appears to represent a slow drift towards the Atlantic "deep" in the Bay of Biscay running north-westwards from Cap Breton, and the north-westward tension seems to represent a drift towards the "deep" trending north-eastwards between Rockall and Ireland These "deeps" themselves are to be attributed, not to "foundering," but to a drift of the "sial" masses of the Central Atlantic banks to the south-west and north-west respectively

EDINBURGH.

Royal Society, February 9.—W. L. **Calderwood**: The relation of sea growth to the spawning frequency in *Salmo salar* From the systematic study of scales of salmon and the calculation of age lengths, the growth of fish which return from the sea to spawn in early life is contrasted with the growth of those which remain for several successive years to feed and grow to a large size without spawning The first and frequently the second year's growth in the sea determines which habit is followed.—F J **Cole**: A monograph of the general morphology of the myxinoid fishes based on a study of Myxine Part VI. Blood vascular and lymphatic systems of Myxine. The anatomical relations of the two systems and the circulation of the blood from one to the other is described An extensive true lymphatic system is present as apart from the so-called veno-lymphatics which belong strictly to the venous system. A fourth (cardinal) heart is described. The liver is an hepato-pancreas, the pancreatic tubules being associated with the branches of the portal vein in the liver parenchyma.—Sir Thomas **Muir**. Theory of compound determinants from 1900 to 1920

MANCHESTER.

Literary and Philosophical Society, February 3.—W. L **Bragg**. (1) Model illustrating the formation of crystals When a solution of a salt is evaporated, positively and negatively charged ions, which are at first distributed in the solutions, pack themselves into a regular pattern. A series of electro-magnets hung by long wires represent these ions They can be charged with opposite polarities by passing an electric current through them. At first they swing about freely in all directions, then as the attractive force increases they group themselves into pairs (molecules), and these pairs pack together to form a regular crystalline body in two dimensions. A slight variation of the experiment shows the difference between acids and bases and the formation of complex acid groups according to the theory of Kossel. (2) Exhibit of diffraction gratings constructed to illustrate the effect of crystals on X-rays. By ruling gratings in which the lines are complex, many of the diffraction effects observed in crystals may be simulated. The gratings are made by taking a contact print from a glass plate ruled with a number of fine lines such as is made for the half-tone printing process. Instead of taking one print, two or more are taken, the plate being moved a very small distance between each exposure, and the times of exposure varied. Thus each line in the grating has several components of different intensities just as each molecule in the crystal is composed of several atoms, all the components or atoms scattering the light or X-rays respectively Very striking diffraction effects exactly like those got in X-ray analysis are obtained.—R W. **James** and W A. **Wood**. The structure of barium sulphate Examination of the spacings of the different planes shows that the space-group is V_h^{16} and that the unit cell contains four molecules and has the dimensions $a = 8{\cdot}852$ Å, $b = 5{\cdot}430$ Å, $c = 7{\cdot}132$ Å By examining the intensities of the different spectra it has been possible to place the atoms with some accuracy The intensities of the spectra of lower order are consistent with the assumption that the SO_4 group is a tetrahedral arrangement of oxygen atoms around a central sulphur atom, the distance sulphur to oxygen being about 1·5 Å The barium and sulphur atoms lie on the reflexion symmetry planes of the structure which are parallel to (010), and necessarily two of the oxygen atoms lie on these planes also.—E C S **Dickson** Experimental demonstration of the Magnus effect: principle of the Flettner rotor ship

PARIS.

Academy of Sciences. February 9.—Charles **Richet**, M **Oxner**, and J. **Richard**. Cooked food and raw food in feeding fish. An account of experiments carried out at the Oceanographic Institute of Monaco on *Cantharus griseus* The fish fed on raw meat showed no differences from those fed on cooked meat up to the 50th day, but after that period the former steadily gained in weight on the latter.—H **Vincent** The pathogeny and conditions of maintenance of the coli bacillus The blood of animals immunised against the *B. coli communis* is rich in the antibody, but the urine contains little or none The immunity does not extend to the kidney or bladder.—G. **Friedel**: Remarks on a recent communication relating to the fatty acids With reference to a recent note of M. Trillat, the author emphasises that the smectic state as defined by him is very different from the crystalline state, and the term cannot be applied to crystals.—Georges **Giraud**: The generalised problem of Dirichlet, Non-linear equations of m variables.—F. **Defourneaux**: Some applications of electrospherical polynomials to the theory of numbers.—Maurice **Fréchet**: Abstract spaces.—Vladimir de **Belaevsky**: The rupture of the Bouzey dam. The deformations of a reduced model ($\frac{1}{10}$) of the Bouzey dam constructed in xylonite have been studied by an optical interference method. From the results of the measurement the conclusion is drawn that the bursting of the Bouzey dam in 1895 was produced by rending.—Henri **Malet**: The idea of the variation of mass, deduced from the formula of the addition of the velocities taken by itself.—Maurice **Le Besnerais** and Raoul **Ferrier**: The electrical constitution of the ether.—Marcus **Brutzkus**: The realisation of chemical reactions in compressors.—

F. **Croze**: The structure of the line spectrum of ionised oxygen.—B. **Szilard**: A new method of examining the interior of pearls. The pearls, immersed in thick cedar oil, are viewed directly by the microscope. Pearls formed on a nucleus of mother of pearl can be readily distinguished by this method from natural pearls.—**Nobuo Yamada**: Particles from polonium with a long path.—Fred **Vlés** and Edmund **Vellinger**: The physico-chemical properties of gelatin; the rotatory power The results of measurements of diffusion, multi-rotation and rotatory powers of solutions of gelatin are given, the variable being the hydrogen ion concentration.——**Lespieau**: The glycol CH C.CH(OH)·CH_2(OH). This glycol was obtained from the chlorhydrin CH : C . $CH(OH)_2$. CHCl as starting point, through the ethylene oxide CH : C . CH_2—CH_2. Its formula was established by its combination with phenyl isocyanate and by titration with bromine It is remarkable as being the first true acetylene derivative failing to give a precipitate with ammoniacal cuprous chloride.—Marcel **Godchot**: Octohydro-phenazine.—Charles **Chéneveau**. The formation of natural dull amber. A transparent pine resin can be rendered opaque by treatment with water at 50° C, under similar conditions peach and cherry gums do not turn opaque, but swell up and form a gel. During the tertiary period the influence of the temperature of the Baltic regions, then tropical, together with the effect of time, would be sufficient in the presence of water at atmospheric pressure to convert the transparent resin into opaque resin.—L. **Royer** New observations on the orientation of ammonium iodide by muscovite mica.—Ch. **Lormand** Analysis of the thermal waters of Chaudesaigues (Cantal).—C. **Dauzère**: The atmospheric vase and the sea of clouds. Observations made at the Pic du Midi.—R **Kuhner**. The nature of the cystids in the Basidiomycetes.—A. **Hée** and R. **Bonnet**: The influence of the dissolved oxygen content of the water on the respiration of submerged plants For the four species of plants studied (*Myriophyllum epicatum*, *Elodea densa*, *Cabomba caroliniana*, *Elodea canadensis*) the intensity of the respiration was not sensibly modified by variations in the dissolved oxygen in the water between 3 cc. and 24 cc of oxygen per litre.—E **Michel-Durand**: Under what form do the tannins exist in Spirogyra? The tannins of these plants are almost completely extracted by acetone and amount to about 3 per cent. of the dry weight. The insoluble tannin compounds, normal in higher plants, are absent from Spirogyra.—Henri **Piéron**: The differential characteristics of the working of the retinal cones and rods.—Jules **Amar**: The stages of vital coagulation.—Jean **Roche**: The respiration of the tissues in avitaminosis and inanition A recent theory, put forward independently by Hess and Abderhalden, attributes to the vitamins a rôle of primary importance in the mechanism of cellular oxidations. According to this theory, avitaminosis is an impoverishment of the cells in respiratory ferments. Experiments on tissue respiration described have given results in opposition to this theory.—P. **Fredet** and René **Fabre**: Study of the localisation in the organism of the alkyl derivatives of malonyl urea. In injections of diethylmalonyl urea (veronal) and allylisopropylmalonyl urea, it has been proved that these compounds fix themselves selectively on the nervous centres, brain and spinal column.—Mme. **Phisalix**: Autopsy of a reticulated python (*Python reticulatus*) measuring 5·75 metres in length.—Robert **Weill**: The nematocysts and spirocysts of the Cœlenterata. Mode of working and differential characters.—O. **Duboscq** and P. **Grassé**: The parabasal apparatus of the Flagellæ and its signification.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 12, December).—H. B. **Wahlin**: The mobilities of the positive ions in helium. The mobility of the positive ion in air decreases if the ion is allowed to "age" before it enters the field in which its mobility is to be measured, due probably to the fact that ions consist of clusters of molecules and not of single charged molecules. A similar result was obtained in helium, but the mobility curves show two definite breaks, due possibly to the presence of two types of aged and two types of unaged ions.—G. P. **Baxter** and H. W. **Starkweather**: The density of oxygen. Little novelty of method is claimed. Three globes were used and weighed by direct comparison with similar exhausted sealed globes. Oxygen was prepared by (1) electrolysis of dilute sulphuric acid; (2) electrolysis of aqueous sodium hydroxide, (3) heating potassium permanganate, (4) heating potassium chlorate and manganese dioxide The average value for the density found from the three series of experiments considered most trustworthy is 1·42901 corrected to 0° C and 760 mm at sea-level, lat. 45°, and this is also the average for the whole set of 22 experiments, each of which consisted of three determinations The value generally accepted hitherto is 1·42905 The new density gives the limiting value of the molal volume under standard conditions as 22·415 litres.—C. T. **Brues**: Observations on the fauna of thermal waters The observations refer chiefly to the thermal springs of the Yellowstone National Park Characteristic of the conditions are the high temperature, presence of unusual quantities of inorganic salts, deficiency of dissolved oxygen, and excess of carbon dioxide. Plants without chlorophyll exist in water at 70°-89° C, and green algæ at 60°-77° C, animal life is found in water at 46°-52° C, but is scarce above 40°-42° C The present fauna includes Protozoa, Arthropoda, Mollusca, and cold-blooded vertebrates, and is generally similar to a brackish-water fauna. This seems to be due to their both deriving from fresh-water organisms.—W. E. **Castle**: On the occurrence in rabbits of linkage in inheritance between albinism and brown pigmentation A race of rabbits with brown pigmentation of the coat gave 25 per cent. pink-eyed and white-coated young with brown at the extremities (Himalayan albinism). Brown is recessive to black pigment and Himalayan albinism to brown The two recessive characters are relatively loosely linked in inheritance. Previous cases of linkage in mammals show less than 20 per cent. of crossing over, here more than 40 per cent. occurs.—E. **Hille**: A general type of singular point.—J. W. **Alexander**. Topological invariants of manifolds.—F. G. **Benedict** and Cornelia Golay **Benedict**: (1) The neutral bath and its relation to body heat Oxygen consumption was used as an index of the basal metabolism of four trained subjects, one woman and three men, first in the laboratory at 15° C and afterwards in a bath of water at 33°-38° C. (neutral bath used as a sedative in psychiatric clinics) The oxygen consumption of the men showed an increase, while that of the woman was practically unchanged. The bath does not tend to lower the metabolism, and the heat production under these conditions is independent of the heat lost to the environment and therefore of the surface area.—(2) Body posture and minor muscular movements as affecting heat production. Oxygen consumption while standing was about 10 per cent. greater, and while sitting 2-3 per cent greater, than while lying down. Movements such as raising one arm or crossing the legs at intervals of less than 1 min also cause increases, and must therefore be proscribed while measuring basal metabolic rates.

Official Publications Received.

University of Illinois Engineering Experiment Station. Circular No. 13: The Analysis of Fuel Gas. By Prof S W. Parr and F. E Vandeveer, Pp. 41. (Urbana, Ill.) 20 cents.

The Use of Fish for Mosquito Control. Pp 120. (New York The Rockefeller Foundation.)

British Museum (Natural History). Picture Postcard Set G. 7. Restorations of Extinct Reptiles. Series No 1. 10 cards in Monochrome. (London. British Museum (Natural History).) 1s.

British Museum (Natural History). Report on Cetacea stranded on the British Coasts during 1923 and 1924 By Sir S. F. Harmer. Pp 84 +1 map (London. British Museum (Natural History).) 8s.

International Geographical Union. Report for the period July 1922–December 1924, with Lists of the National Committees and the Statutes, etc Edited by Sir Charles Close Pp. 64. (London: Printed by Harrison and Sons, Ltd.)

Geological Survey of Uganda Memoir No. 1: Petroleum in Uganda By E J Wayland Pp 61+4 maps. (Entebbe.) 5s net.

Agricultural Research Institute, Pusa. Bulletin No 147 List of Publications on Indian Entomology, 1922 (Compiled by the Imperial Entomologist.) Pp. 42. 7 annas Bulletin No 155 List of Publications on Indian Entomology, 1923 (Compiled by the Imperial Entomologist.) Pp. 59 11 annas. (Calcutta Government of India Central Publication Branch.)

Catalogue of Indian Insects Part 4 Trypetidæ (Trypaneidæ) By R Senior-White. Pp iii+33 8 annas. Part 5 Nitidulidæ By S. N Chatterjee. Pp. vi+40 10 annas (Calcutta Government of India Central Publication Branch.)

Ministry of Finance, Egypt. Survey Department Geological Survey of Egypt. Palæontological Series, No 6 Catalogue des invertébrés fossiles de l Egypte représentés dans les collections du Musée de Géologie au Caire. Par R Fourtau. Terrains Jurassiques 1re partie Echinodermes Pp xi+39+5 planches (Cairo: Government Publications Office.) 5 P T

National Institute of Industrial Psychology. Annual Report and Statement of Accounts for the Year ended 31st December 1924, to be presented at the Fourth Annual Meeting of Members to be held at the Offices of the Institute, 329 High Holborn, London, W C.1, on Wednesday, 25th of March 1925, at Five p.m Pp 17 (London: 329 High Holborn, W.C 1.)

Conseil Permanent International pour l'Exploration de la Mer Rapports et Procès-verbaux des Réunions Vol 36 A Short Account of the Statistics of the Sea Fisheries of England and Wales By T. Edser Pp 27 (Copenhague Andr Fred Host et fils.)

Report of the Rugby School Natural History Society for the Year 1924. Pp. 42 (Rugby.)

Diary of Societies.

SATURDAY, MARCH 28.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Doncaster), at 11 A M

MIDLAND INSTITUTE OF MINING ENGINEERS (at Danum Hotel, Doncaster), at 2.15.—Prof J A. S. Bitson and W L. Grassham Notes on Devices to prevent Overwinding.—J H Cockburn Mines (Working Facilities and Support) Act, Part I, 1923.—Dr E. W Smith and F. S. Townend Manufacture of Coke-oven Coke

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J H Ashworth. The Nervous System and some Reactions (I.) Of Ciliate Protozoa and Sea Anemones

MONDAY, MARCH 30

INSTITUTE OF ACTUARIES, at 5.—R D Anderson Apportionment of a Trust Fund between Life Tenant and Reversioner.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—Informal Discussion on Road *v* Rail Transport.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7 15.—Informal Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Great Northern Hotel, Leeds), at 7 15.—G F. Pickering Examination of Oxidation Products from Fatty Acids and Oleines.—Prof. N. M Comber: The Laboratory Examination of Soils.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. B. Pite. The Architectural Treatment of Ferro-Concrete

TUESDAY, MARCH 31.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4 15.—Prof H. Pringle The Identity of Vitamin A. The Comparative Effects of Human and Cow Milk.—Prof. J Wilson. The Variations in the Quantities of Food required by Cattle for Maintenance and Fat Production with various kinds of Rations.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. Cameron: Some Forms of Vomiting in Infancy (Lumleian Lectures) (II.)

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. S. Eddington: The Internal Constitution of the Stars (II.).

ROYAL SOCIETY OF MEDICINE, at 5.30.—Dr. W. Langdon Brown, Prof Swale Vincent, L. Pugh, Dr. H Gardiner-Hill, K. Walker, Dr. L. Williams, Dr H Crichton Miller, J. E. R. McDonagh, and others: Special Discussion on Endocrine Therapy

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 6 30.—Annual General Meeting.—At 7.—A. Pereira: Personal Reminiscences of the Mount Everest Expedition, 1924.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—Dr. R Lessing: The Inorganic Constituents of Coal.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—Capt T. G. Leggott: Modern Engineering Development.

WEDNESDAY, APRIL 1.

WOMEN'S ELECTRICAL ASSOCIATION (at 26 George Street, Hanover Square), at 3.—Miss M. Partridge: What is Electricity?

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Major A. G Lee and A. J. Gill The Leafield Coupled Arc.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Annual Meeting

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Col. T. F. Purves. The Post Office and Automatic Telephones.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—W. Dickson: Quantitative Estimation of Cotton, Linen, and Wood Fibres in Paper Pulp.—Dr. J. C. Drummond: Vitamins in Bread.—G D. Elsdon: Proposed Standards for Lemon Cheese Discussion on the Desirability of Standards for Food Products.—Dr P H Prausnitz Demonstration of Laboratory Filters made of Sintered Glass and their Various Uses.

ROYAL SOCIETY OF ARTS, at 8.—W. Nunn: Siam Its Prospects and Possibilities.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Sir Charles Ballance, L. Colledge, and L. Bailey: Some Results of the Experimental Anastomosis of Certain Nerves with Neighbouring Nerves (with Cinematograph Demonstration).

THURSDAY, APRIL 2.

ROYAL SOCIETY, at 4.30.—Prof. H E Armstrong: Studies on Enzyme Action XXIII The Oxidase Effect and the Phenomena of Oxidation in General Carbonic Oxide.—N. K. Adam and G Jeasop: An Explanation of the so-called Intertraction Phenomenon between Solutions and the Molecular Significance of Negative Surface Tension.—*To be read in title only.*—Dr Jane Sands Investigation of Oxidation in the Blood of Earthworms.—R Snow: Conduction of Excitation in the Leaf of *Mimosa Spegazzinii*.—Dorothy Adams: Investigations on the Crystalline Lens.

LINNEAN SOCIETY OF LONDON, at 5.—W. C F Newton. The Cytology of the Genus Tulipa.—W R. B Oliver. Biogeographical Relations of the New Zealand Region

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. Cameron Some Forms of Vomiting in Infancy (Lumleian Lectures) (III.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—T Thorne Baker: Chemical and Physical Effects of Light (II): Transmission of Light Images by Electricity.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Ben Greet: Plays for Children.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. M Sayers and others: Discussion on Electricity Supply Tariffs.—G Wilkinson and R McCourt Electricity Supply Tariffs Their Simplification by Discrimination

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7 30

CHEMICAL SOCIETY, at 8.—C. S Gibson and J. L. Simonsen: The Formation of *d* 2:2:4-trimethylcyclohexan-4-one-1-carboxylic Acid from *d*-camphorquinone.—W. H Gray Aromatic Esters of Acylecgonines.

FRIDAY, APRIL 3.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. J. Freeman, Dr. B. Kelly, and others Discussion on Paroxysmal Rhinorrhœa, or Vaso-motor Rhinitis

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Acromegaly and Allied Disorders of Growth.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Prof. W. A. Craigie. Dictionary Evening

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Annual Meeting

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual Meeting) (at 16 St. Mary's Parsonage, Manchester), at 7.—Dr. C H. Lander: Smokeless Fuel and Oil

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Modern Developments of Gas Production.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. W. Tookey: Engineering Contracts.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—E. A. Davies: Ships' Life-Saving Appliances.

ROYAL AERONAUTICAL SOCIETY (Scottish Branch), at 8.—Major G. H. Scott: The New Empire View of Airships and the Practical Possibilities arising therefrom.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Daniel Hall: The Productivity of English Land.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool).—Annual Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester).—Annual General Meeting

SATURDAY, APRIL 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. H. Ashworth: The Nervous System and some Reactions (II.): Of Marine Annelids and Earthworms.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—J. Reid Moir: The Antiquity of Man in Ipswich (Presidential Address).

PUBLIC LECTURE.

SATURDAY, MARCH 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Living Animals of the Sea-shore.



SATURDAY, APRIL 4, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2892, VOL. 115]

The Proscription of Darwinism.

ON March 23 the Governor of Tennessee signed a Bill which enacts that "it shall be unlawful for any teacher in any of the universities, normal schools, and all other public schools of the State which are supported in whole or in part by the school funds of the State to teach any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man is descended from a lower order of animals." This Act marks another important advance in the outlawry of Darwinism in American education. Tennessee is one of the most enlightened of the Southern States, but it has followed the example of five others. The last previous action, as stated in Prof. J. W. Gregory's "Menace of Colour," 1925, p. 74, was the unanimous decision last July of the State Education Committee of Georgia to refuse grants to any school or university which teaches the doctrine of evolution. The Legislature of Florida had earlier decreed, also unanimously, that it is "contrary to the public welfare for teachers paid by taxation to teach as a fact any hypothesis that links man in blood relationship with any lower form of life." A Bill with the same purpose was defeated in Kentucky by one vote only. Text-books of biology have been debarred from schools in North Carolina because they asserted a relationship between man and monkeys.

This proscription of Darwinism is the result of two main impulses—one religious, the other racial. The religious impulse is the more publicly expressed, and is doubtless the more influential. The Fundamentalists in the United States are as powerful as the Evangelicals were in England seventy years ago. The conclusions of "The Origin of Species" were denounced by Bishop Samuel Wilberforce to the British Association at Oxford in 1860; and his argument that they are inconsistent with Genesis had to be taken seriously. The support to that position had become negligible in England fifty years ago; but its survival in the United States is shown by the writings of Mr. W. J. Bryan, who has been thrice candidate for the Presidency, and was State Secretary in Wilson's cabinet. His theological books, including his "The Menace of Darwinism, and the Bible and its Enemies" (1921), "In His Image" (1922), and "Shall Christianity remain Christian?" (1924), are written in the frame of mind of Wilberforce; and as the Bishop repudiated an ape as his ancestor, Bryan represents Darwinism as adding insult to injury by insistence that man has descended, not from an American, but

from an African monkey. Bryan regards the Modernists as descending from Christianity to Atheism by successive adoption of seven grievous errors—"The Bible not infallible; Man not made in God's image; no miracles; no Virgin Birth; no Deity; no Atonement; no Resurrection." The multitude of those who make this descent is attributed to Darwinism. "The principal objection to Evolution," says Bryan, "is that it is highly harmful to those who accept it, and attempt to conform their thought to it Evolution does not ruin all who accept it, neither does smallpox kill all who take it. In fact only five per cent of those who take smallpox die of it. The spiritual mortality among evolutionists is greater than that." Bryan is probably right in his view that Darwinism has been the most effective factor in undermining belief in the literal inspiration of the Bible. Hence it is charged with being the main cause of the asserted decline in American morals and ethics. "Darwinism," says Bryan, "chills the spiritual nature and quenches the fires of religious enthusiasm." Fairhurst, in his "Atheism in our Universities," complains that their influence is ruinous; he declares that most of the students drink, half of them gamble, and only a tithe of them are interested in religion. A census is claimed to show that eighty-five per cent. of the students enter the Universities as Christians; the number of sceptics is doubled in the first year and trebled by graduation. Some Fundamentalists describe American society as "brought to the verge of ruin by a godless philosophy," which is based on evolution. Hence Bryan declares "Evolution is the Menace of Civilisation. It is the greatest menace to civilisation as well as to religion. Belief in God is the fundamental fact in society; upon it rests all the controlling influences of life. Anything that weakens man's faith in God imperils the future of the race."

Bryan's attempt to refute Darwinism is futile. It is, he says, "not science at all; it is guesses strung together." In support of its unscientific character he quotes "Dr. Etheridge, Fossiologist of the British Museum," and misrepresents modern authorities such as Bateson. The main charge against it is that it is "not only groundless but absurd and harmful to society," as it rests on the brute doctrine of survival of the fittest, which is said to encourage selfishness, to be fatal to the spirit of brotherhood, and to render certain the destruction of modern culture by international and industrial war. Men with such convictions naturally feel bound to prevent national funds being used in the spread of such pernicious doctrine. No teacher in a public school in the States would be permitted to teach that monarchy is superior to republicanism, and Bryan objects to public funds being used to sap national faith by "teaching daily what cannot be true if the Bible be true." He claims that men of science are a small minority and should not be allowed to use the public schools for the dissemination of their subversive dogmas.

The campaign against Darwinism also gains support from the objection to its evidence of a common ancestor for the Negro and Caucasian. The extent of this impulse is uncertain, but it is significant that the six States which have taken action against evolution are all in the south. On this question the Bible would appear to agree with Darwin; for did not Paul on Mars Hill declare that God "hath made of one blood all nations of men"? Some Americans avoid this difficulty by denying that negroes are descendants of Adam and claim that accordingly they are not men. The negro is a soulless animal at the head of the ape family! Believers in Noah's Deluge may fairly claim that the negro cannot have varied from the white stock as quickly as would be necessary to explain his appearance on earlier Egyptian records. If the negro be not a descendant of Noah, the Bible statements regarding "all men" are held not to apply to him.

The inter-racial difficulties in the southern states have certainly helped the anti-Darwinism agitation indirectly; for their educational backwardness and the poverty of one section of their people is due to the presence of the negro and to cheap negro labour. Recent statistics show that in two counties in North Carolina the white crofters and "renters" have a cash income per person of fourpence and sevenpence per day respectively; the corresponding classes of negroes earn a penny a day more. Families with such income cannot afford education, books, newspapers, doctors, or enjoy a reasonable standard of life. It is not surprising that they retain beliefs which, according to British notions, are decades out of date.

Bryan's eloquence and sincerity have made him perhaps the most powerful recent individual influence in American politics. But he has often failed to persuade his countrymen to adopt his policy. His present appeal for trust in the Rock of Ages rather than in "Ages of Rocks" may carry still further the educational outlawry of Darwinism; but it will probably fail in the end as completely as his famous appeal to the United States to adopt bimetallism "to save a world crucified on a Cross of gold."

Isostasy.

Isostasie und Schwеremessung: ihre Bedeutung für geologische Vorgänge. Von Prof. Dr. A. Born. Pp. iii + 160. (Berlin: Julius Springer, 1923.) 2·20 dollars.

THE variation from place to place of the intensity and direction of the force of gravitation is one of the comparatively few phenomena from which we can obtain some knowledge of the nature of the earth's interior. We owe to Pratt and Airy the demonstration in 1855 that, broadly speaking, different regions of the earth's crust balance one another, or, as it is now expressed, are in a state of isostasy; that the weight of mountain masses above the sea-level is compensated by a defect of density below them, and that ocean deeps are underlain by material of high density. But, whereas Pratt believed that the high places of the earth were the result of expansion of the material beneath them, Airy compared a mountain range to a log of wood floating in water, which it displaced and by which it was buoyed up. After nearly seventy years the same difference of opinion as to the real meaning of isostasy continues to persist.

In his treatise on isostasy and gravitation, Prof. Born has furnished us with a comprehensive exposition of the different methods of interpreting the results of gravity determinations and of the evidence that, in conjunction with geological data, they afford of the internal structure of the earth.

The intensity of gravitation at any point is accurately determined by observing the number of swings of a pendulum of known length during a period recorded by a chronometer, checked by astronomical observations or wireless time-signals. At sea other less exact means have hitherto been employed, but Dutch observers have now shown us that pendulum observations can be carried out in a submarine sunk to a sufficient depth to be practically free from wave action.

In the United States, numerous observations have been made by J. F. Hayford and William Bowie, of the U.S. Coast and Geodetic Survey, and the values obtained have been made the basis of calculations to show how far the principle of isostasy corresponds with the facts (U.S.C. and G.S. Special Publications, Nos. 10, 12, 40, 69, and 99).[1] In these the value experimentally determined, g, is compared with a calculated value, γ_c, based on the assumed value, γ_o, at sea-level[2] at a point directly below. To obtain g_c from γ_c the following corrections are made: (1) for difference of altitude; (2) for the attraction of the local rocks above sea-level, assumed to have a density of 2·67; (3) for the defect of density below sea-level necessary to compensate for the weight of the rocks above it. The difference $g - g_c$ is the isostatic anomaly of Hayford and Bowie. It is quite small, usually less than 0·05 of a dyne, but occasionally approaching a tenth of a dyne.

In calculating the effect of the compensating defect of density, they assumed that it was distributed uniformly below the point of observation from sea-level down to a depth known as the level of compensation, where the density and pressure were supposed to be everywhere uniform. Various depths were taken as the basis of calculation, and that which gave the lowest isostatic anomalies was supposed to be the nearest approximation to the level of compensation. On this basis Bowie obtained for mountainous areas a depth of 95 km. Calculations by Hayford based on deflexions in the direction of gravitation gave a depth of 97 km. Accordingly, Bowie assumed a depth of 96 km. in place of 113·7 km. previously adopted by the Survey. The depth of compensation derived from gravity data at low stations would be indeterminate, but there can, in my opinion, be little doubt that in plains and even plateaux a level of practically uniform density and pressure would be found at a much smaller depth, say 20 or 30 km.

The truth is that the idea of a level of compensation does not correspond to any important reality in Nature. It has no more significance than the level of the base of the largest and deepest of a number of icebergs. It seems obvious to a geologist that the amounts of compensation corresponding to different elevations are not to be represented by columns of equal depth and different densities, but by columns of approximately equal densities but varying depths In other words, the loftier the mountain range the deeper its foundations extend into the earth. Both mountains and their foundations appear to be mainly composed of similar comparatively light material, the "sial" (sedimentary and acid crystalline rocks), which in general rests upon and in mountain areas displaces more or less the heavier "sima" (basic material) below.

Isostatic anomalies are in some cases to be attributed to the support afforded to local elevations by the intrinsic strength of the earth's crust. This support is, however, given only for a limited time, except by rocks in the closest proximity and at a comparatively low temperature. Isostasy is a condition to which there is a constant approximation but which is never reached; for new developments, such as sedimentation or erosion, the formation or melting of ice-caps, and lateral compression or tension, are continually arising, which tend to destroy it, and then the process of

[1] Reference should also be made to the suggestive address to the Geological Society of America by the president, David White, on "Gravity Observations from the Standpoint of Local Geology" (Bull. Geol. Soc. Am., vol. 35, pp. 207-278, 1924). See, in addition, Andrew C. Lawson on the Geological Implications of the Doctrine of Isostasy, Bull. Nat. Research Council, vol. 8, part 4, pp. 24, 1924.

[2] By sea-level is meant the surface of the rotation ellipsoid adopted in 1924 by the U.S. Survey for the figure of the earth. As a matter of fact the computation is first made on the basis of the Helmert triaxial ellipsoid of 1901, with a subsequent correction (for U.S.A.) to the value of $g - g_c$ of − 0·008 dyne.

adjustment has to recommence once more. Other anomalies, perhaps the majority, can be best explained by the local occurrence near the surfaces, of rocks or deposits of a density differing in a marked manner from that assumed.

There is another method of reduction of gravity determinations, that of Bouguer, which throws more direct light upon the geological structure of the crust. The observed value, g, is reduced to what it would be at sea-level [3] if the whole of the rocks above (near enough to exercise any appreciable attraction on the point of observation) were removed This value is indicated by the symbol g''_o, and the difference $g''_o - \gamma_o$, where γ_o is the theoretical value at sea-level, affords infofmation of the depth to which the sial extends below it.[4] This is illustrated by an interesting map, by Kossmat and Lissner, of Middle Europe from Denmark to Sicily, showing the relation of $g''_o - \gamma_o$ to the great folds of sial, which form both the mountains above and their foundations below.

The whole subject of the relation of isostasy to mountain building, erosion, sedimentation, glaciation, and different types of earth structure is discussed in detail by Prof. Born. He makes the freest use both of the American determinations and of those of the Indian Topographical Survey, which will always remain a monument of the enterprise of Sir Sidney Burrard and his colleagues Prof. Born gives a detailed account of the work of Hecker and others in marine areas, and of the light thrown by the results obtained by Hecker Borras, Kohlschütter, and Krenkel on the nature of the rift valleys of Africa and South-western Asia.

Other subjects dealt with by Prof. Born are pseudo-anisostasy, the apparent departure from isostatic adjustment resulting from the attraction of rocks which do not form part of the column immediately below the point where gravity is determined, so that their weight is not included in that of the column; observations in oceanic volcanic islands—which usually show an excess of gravitational force due to a lag of isostatic adjustment; the relation of earthquakes to the want of isostatic adjustment; and generally the assistance afforded by observations of variations in gravitational force in the interpretation of the meaning of the present configuration of the world, and of the changes which have taken place in its past history.

Prof. Born's work is usefully supplemented by two memoirs from the Finnish Geodetic Institute.[5] Dr. Heiskanen has calculated the isostatic anomaly in a number of localities in Europe and the Caucasus. These calculations have been made, first on the same lines as those employed by Hayford and Bowie, and secondly on the Airy hypothesis that it is the *depth* of the lighter material that varies. From the isostatic anomalies obtained in this way it would appear that the latter hypothesis is more in accordance with gravity determinations than the former. This is the case even with the determinations in the United States with which Hayford and Bowie have worked. At the same time, the results obtained indicate that the thickness of the "earth's crust" (presumably that of the sial) below sea-level varies in different localities. Another important conclusion is that the idea that mountain ranges are not compensated separately but only in conjunction with their marginal depressions (Randsenken), and that the former are therefore under-compensated and the latter over-compensated, must now be abandoned. It has been supposed that the Harz and Riesengebirge are uncompensated. Dr. Heiskanen denies that this is the case. The detailed account of the results of the triangulation of South Finland is also of great interest. It contains (*inter alia*) a comparison of the deviations of the direction of gravity actually observed at the triangulation stations with those calculated from the orographical features and the compensation determined by the methods of Hayford and Bowie. The knowledge of the details of the topographical features is, however, at present too imperfect to allow any conclusions to be drawn.

Comparatively few contributions to gravitational data have come in recent years from the British Empire—with the conspicuous exception of India—though so much requires to be done within its limits. It is greatly to be desired that we shall in the future take a due share in this important work.

The recent meeting of the Geodetic Union in Madrid included a section devoted to isostasy. Unfortunately, the German and Austrian men of science, who have done so much to advance knowledge in this direction, were not permitted to attend. Their co-operation would have been all the more valuable because they have worked on lines somewhat different from those pursued in India and the United States. They have taken the fullest advantage of the information afforded by a century of geological research on the structure and past history of the earth's crust. It is absolutely necessary that geodesists and geologists should work in the closest association with one another if trustworthy conclusions are to be reached. JOHN W. EVANS.

[3] Here it is the surface of the "geoid," the level at which the sea would stand if admitted by canals to a point immediately below the point of observation. It differs but little from the triaxial ellipsoid of Helmert or the rotation ellipsoid of Hayford and Bowie.

[4] It would be better if the expression $\gamma_o - g''_o$ could be employed, where γ_o represented what would be the force of gravity at sea-level if the earth's crust below it were composed entirely of sima, for this difference would roughly correspond to the depth of the sial below sea-level.

[5] "Untersuchungen über Schwerkraft und Isostasie," von W. Heiskanen; "Die Beobachtungsergebnisse der südfinnischen Triangulation in den Jahren 1920–23" (Veröffentlichungen des Finnischen Geodätischen Institutes, No. 4 and No. 5). Helsinki, 1924.

Early Chemistry.

The Story of Early Chemistry. By Prof. John Maxson Stillman. Pp. xiii + 566. (New York and London: D. Appleton and Co., 1924.) 18*s.* net.

THE "noticeable gaps" which so many books are "intended to fill" are often discernible only to the authors. However, the absence of any book in the English language which deals adequately with the early history of chemistry will have been brought home very forcibly to all those whose business or inclination has led them to inquire into the available literature on this subject. It is therefore with genuine pleasure that we welcome the late Prof Stillman's thoughtful and scholarly treatise—a pleasure that is, alas, tinged with regret at the author's death just before the book was published.

As Prof. Stillman remarks in his preface, modern historians of chemistry have laid the emphasis upon the more recent development, so that it was very desirable to write a history of early chemistry which should incorporate the results of the investigations of Berthelot, Duhem, von Lippmann, Ferguson, Sudhoff, and other scholars. It may be said at once that the author has admirably accomplished the task—no light one—which he set himself. His book is brightly written, well balanced, and extremely accurate both in the main ideas and in the illustrative detail. No scientific library can afford to be without it, and this by reason of its intrinsic merits, quite apart from the fact that it has at present no competitors. A very valuable feature of the book is that, while avoiding a show of erudition, it gives full references to authorities for all important statements, and will thus prove useful to those who are engaged in research upon the history of chemistry.

In a field which extends from the beginnings of civilisation to the Chemical Revolution, no one man can hope to be infallible throughout. Prof. Stillman was especially interested in the fifteenth century, and in his account of this period he is seen at his best. He evidently has here a close acquaintance with the original sources, and his description is penetrating, sympathetic, and sound. For the other periods, he has relied chiefly upon the work of other scholars, but his judgment in the use of authorities is seldom at fault and is generally very shrewd. Particularly good is the first chapter, which deals with the practical chemistry of the ancients. On the question of the origin of chemistry he is not so trustworthy, and seems to be quite unaware of the theory of the growth of civilisation now so warmly advocated by Prof. Elliot Smith and Mr. W. J. Perry—a theory which has a very direct bearing upon the problem of the birth of chemistry.

The theories of the ancients upon matter and its changes (Chapter iii.) are described adequately but by no means comprehensively. Justice is scarcely done to the Greek thinkers, although we are pleased to see the stress which Prof. Stillman lays on the *Timæus*, the influence of which upon medieval chemical thought was very considerable.

That the description of chemistry in Islam is thoroughly unsatisfactory is no reflection upon Prof. Stillman. From the published work on this subject which he had at his disposal, he could not possibly have produced a better account than he has done. He might, however, have got an Orientalist to look through his transcriptions of proper names, and thus have avoided such needless errors as *Moaonia* for *Mu'āwiya*, *Oneeyade* for *'Omayyad* (p 175), and *Eç-Confy* for *Al-Sūfī* (p. 176). These are details which should receive attention in the second edition.

In dealing with the seventeenth century, again, Prof. Stillman has almost entirely neglected the brilliant series of chemists at the Jardin des Plantes—Béguin, Davidson, Glaser, and others—who did much to prepare the way for the great Lemery. Taken as a whole, however, the book is a worthy example of modern American historical scholarship, and may justly claim to rank with Cajori's "History of Physics," Smith's "History of Mathematics," and Lynn Thorndike's "History of Magic and Experimental Science."

E J. HOLMYARD.

On Being Born and Well Born.

Genetics and Eugenics: a Text-Book for Students of Biology and a Reference Book for Animal and Plant Breeders. By Prof W E. Castle. Third edition. Pp. viii + 434 + 60 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1924.) 12*s.* 6*d.* net.

THE fact that this third edition is subdivided into forty-two chapters, six of them new, may provide an indication of the variety of the topics which interest the geneticist. In American literature this book, not the least remarkable feature of which is its cheapness, occupies the position which Punnett's "Mendelism" and Thomson's "Heredity" together hold on the eastern side of the Atlantic: it offers to a very wide public an introduction to genetical fact and theory and some notion of the applications of the science in agricultural and sociological endeavour. Associated with this edition there is a laboratory manual which outlines a very useful half-year's elementary experimental course in genetics. Most of the experiments demand the employment of *Drosophila melanogaster*, but this does not make the manual unsuitable, for there is an adequate supply of this

unrivalled experimental material now available in Great Britain as well as in the United States.

The book is not meant to be a text-book for a class in genetics: the intention of its writer is that it should be a text-book for students of biology and a reference book for animal and plant breeders. The characteristic stamp of the personality of the author is too deeply impressed upon its pages, in our opinion, for the book to be the ideal introduction to the subject for the student of general biology, and the value of those chapters which deal with the phenomena of inheritance in the different species, great as it is to-day, must quickly become depreciated in view of the recent appearance of such monographs as are included in "Bibliographia Genetica" To the geneticist, however, the book is most attractive, for in no other form could the views of the author, who, both as teacher and as experimenter, has contributed so notably to our knowledge of genetics, be so attractively placed on record

There is abundant evidence in this book that Prof. Castle knows his rodents: that he knows his fowl as well is not so certain. On p 77, for example, he submits that "one condition on which the crowing instinct of cocks rests is the production in its body of substances produced by the testis." While it is certainly true that the gonadless fowl does not crow, it is equally true that a cock castrated and with an ovarian implantation will do so, and that a hen, perfectly normal in structure and functioning in every way as a hen, will, in the protracted absence of the male, crow most vigorously, though her voice may not be so full of challenge On p. 300 it is stated that "fowls of both sexes will develop the same plumage characters, viz. the full plumage of normal males, if no secretions interfere." It is true that the plumage of the capon and the poularde is as that of the normal male in colour and structure, but that of the gonadless bird is far more luxuriant in its growth and far looser in its texture than that of the functional cock. We think also that Prof. Castle accepts with too little reserve the suggestion that the "luteal" cells in the ovary of the hen and in the testes of the henny-feathered cocks are the source of an internal secretion which inhibits cocky-feathering. The weight of modern opinion is quite opposed to this contention.

In discussing the relation of Mendelism to mutation and evolution, the author submits that the Mendelising characters of the domesticated mammals consist very largely of such economically unimportant qualities as coat-colour, hair-length, or hair slope, and that the really valuable characters, such as those of size, proportion, early maturity, milk-yield, butter-fat content, wool, and fecundity, are not typically Mendelian in their inheritance, but are examples of blending. We were about to debate the question as to what exactly the author regards as typically Mendelian when a few lines further on we found that Prof. Castle acknowledges that very likely the inheritance of these complex characters of economic importance is also Mendelian. He provisionally accepts the conception of multiple factors, but is mistaken in assuming that such a theory demands that there shall be no dominance.

Forty-seven pages are devoted to eugenics. In a book such as this, written for such a public, it is indeed desirable, we think, that an outline of the facts of human inheritance should be included, for the determination of the extent to which mankind is subject to the general principles of genetics is most certainly a biological problem and one that should be brought to the notice of the student of biology. To determine how far these principles are socially controllable, on the other hand, is a problem for the sociologist, and Prof. Castle, a geneticist, makes no serious attempt to deal with it. However, he closes the book with a somewhat pessimistic chapter on "The Possibility and Prospects of breeding a better Human Race," in which he calls largely upon the conclusions of Prof. Cattell, drawn from the latter's study of the families of the one thousand leading men of science of the United States

We commend this book especially to those who enjoyed and so ceaselessly quote "Eugenics and other Evils" They will find therein such conclusions as the following reached by one who is qualified to speak with some authority. The normal unperverted instincts of the average man have a distinctly eugenic trend. Cupid is a safer guide in matrimony than a licensing board. Racial crossing among men, as among domesticated animals, is biologically beneficial within limits. This mixture of elements not too dissimilar, provided the social heritage is not unduly disturbed, is on the whole beneficial. Biologically the human race can be improved only by improvement of the germplasm. If, as seems probable, acquired characters are not to any considerable extent inherited, then environmental agencies affect man chiefly culturally, not biologically. Practically we are limited to such eugenic measures as the individual will voluntarily undertake in the light of present knowledge of heredity It will do no good, but only harm, to magnify such knowledge unduly, or to conceal its present limitations. We should extend such knowledge as rapidly as possible but not legislate until we are very sure of our ground.

With such conclusions all geneticists will agree. This being so, it is as unjust to blame the geneticist for the mishandling by the lawmaker or enthusiastic sociologist of the facts that he discloses, as to hold the chemist responsible for the adaptation by others of the results of his research to the purposes of war. F. A. E. C.

Our Bookshelf.

Meteorological Office: Air Ministry. British Rainfall, 1923. The Sixty-third Annual Volume of the British Rainfall Organisation. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1923, as recorded by about 5000 Observers in Great Britain and Ireland. (M.O. 269.) Pp. xxii+256. (London: H.M. Stationery Office, 1924.) 15*s.* net.

AN analysis of the rainfall for the year is given covering the whole of the British Isles. The year was decidedly wet, being the wettest year since 1916 except in Ireland. The largest excesses occurred in the west. There were more days with rain than in any other year since comparable statistics began in 1903. The average monthly rainfall during the year over the British Isles as a whole varied from 6·5 in in February to 1·4 in in June; only two months, March and June, showed considerable deficiencies. February 1923 is said to be probably the wettest February on record. Rainfall maps for the British Isles are given for each month, as well as for the summer and winter seasons and for the year.

Examples of dramatic weather during the year are given, these occasioning floods in different parts during July and November. Serious floods occurred at Carrbridge in Inverness-shire on July 8, and on the night of July 9-10 a memorable thunderstorm was experienced, and about 7000 flashes of lightning occurred during 6 hours in London and the suburbs, while 4·55 in. of rain fell in Sussex.

A special article is given on the fluctuations of annual rainfall; a comparison is made of different groups of 35 years in the period 1868 to 1921, and also with the standard period 1881 to 1915, the 35 years' average in general use in the Meteorological Office. The averages for the different periods of 35 years show a good general agreement. C. H.

Bearbeitung einheimischer Tiere. Herausgegeben von Prof. Dr. E. Korschelt. Erste Monographie: Der Gelbrand *Dytiscus marginalis* L. Erster Band. Pp. v+863. Zweiter Band. Pp. vii+964. (Leipzig: Wilhelm Engelmann, 1923–24.) n.p.

THESE two bulky volumes constitute the first of a series of monographs dealing with the fauna of Germany, the subjects selected forming a series of "types" of the animal kingdom for study in the university courses. Probably no better subject for the study of insect structure and metamorphosis than the "Gelbrand" could have been selected. Not only is the Great Water-Beetle hardy and easily kept in captivity, with a comparatively rapid metamorphosis, but it illustrates remarkably well the specialisation of a primitive type in response to the special circumstances of its environment.

Vol. 1 deals with the skeletal system, its appendages and sense organs, and the nervous, muscular, respiratory and circulatory systems of both adult and larva. Vol. 2 completes the structural treatment with the consideration of the fat-bodies, and the alimentary and reproductive systems, passing on to development and metamorphosis and various aspects of its bionomics. Finally, there are two very interesting chapters on its early literature and systematics. After each chapter is given a very full bibliography for that particular part of the subject. Both volumes are abundantly supplied with excellent illustrations.

Owing to unavoidable delay in the appearance of the work as a whole, it was felt that the results of certain pieces of research should be separately published in anticipation, so that some of the chapters in the complete work are practically reprints of papers previously published by Dr. Korschelt or his collaborators.

In view of the great attention to detail evidenced throughout the work, it is a little surprising to find no mention of the "pigment-spot" on the wings, an organ that has recently been claimed to serve a stridulatory function, neither, indeed, do we find any reference to the well-known stridulatory powers of the insect, and but the briefest mention of Finkler's experiments on the transplantation of the head from one individual to another.

An index would have facilitated reference, though its lack is to some extent compensated for by a very full list of chapter headings and subheads for each volume.

A History of Bleaching. By S. H Higgins. Pp. viii+176+9 plates (London Longmans, Green and Co., 1924.) 10*s.* 6*d.* net.

AN investigation into the early history of any industry is of much interest, and may be of considerable value in throwing light on modern practice. Sometimes, as in the case of the bleaching of textiles, fairly detailed records of ancient processes are found, but it is not possible to compare the results obtained then and now, because a fabric bleached even one hundred years ago inevitably will have become more or less discoloured. On the other hand, there are many cases in which we can examine the results of ancient craftsmanship, but have no knowledge of the methods by which they were produced.

The demand for a "perfect" white on cotton, linen, and other textiles is comparatively modern. From an æsthetic view-point, the slightly brownish or greyish tint of white, which must have been the ultimate product of the bleacher before the introduction of chloride of lime, is more pleasing than the more luminous bleached white of to-day, which is probably the outcome partly of trade competition and partly of the requirements of some modern methods of textile printing.

The development of bleaching processes has taken place along two main lines, chemical and mechanical, and Mr. Higgins in his book traces the improvements due, in the first place, to the increase of chemical knowledge, and secondly, to the necessity of dealing with larger quantities of material. Chemical engineering received its early stimulus through the exigencies of the alkali industry and its offshoots, and thus early turned its attention to bleaching and the allied industry of calico printing; the mechanical developments in dyeing processes coming much later.

With the single exception of the introduction of bleaching powder about the beginning of the nineteenth century, there has been no fundamental change in bleaching processes since a very early period. The magnitude of the industry at the present time is indicated by the statement in the last paragraph of the book that about 2,000,000 *miles* of cloth are bleached

annually in Great Britain, a statement which may be approximately accurate if the amount of cloth which is partially bleached as a preliminary to dyeing or printing, is included. W. M. G.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. 26: Botryllus. By E. Catherine Herdman. Pp. xi+40+6 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1924.) 4*s.* 6*d.*

THE author of the present volume, on the compound Ascidian Botryllus, is a daughter and pupil of the late Sir William Herdman, who himself, twenty-five years ago, wrote a description of a simple ascidian as the first volume of the series to which this is the latest addition

The editors of the series explain in a preface the interest attaching to Botryllus, and its advantages as a representative of the group to which it belongs. Miss Herdman's account, which follows, is carefully done, well arranged, clearly written, and excellently and fully illustrated by means of six plates, one of which is in colours. Besides the description of the anatomy, the author gives sections on embryology and development, and on the formation of the colony, as well as paragraphs on such subjects as coloration and the systematic position of the family. There are interesting references to the germ-layer theory in relation to the formation of the organs in the asexually produced blastozooids; to the mode of capture of the food particles; to the functions of the neural gland and dorsal tubercle; to the cause of the curious recurring alternations in the direction of the blood-flow; and to the special functions of the colonial vascular system. It is, however, to be regretted that in a book which the editors hope "will be found of value by students of biology in laboratories and in marine stations, and will be welcomed by many others working privately at marine natural history," the author has not included some account of the most suitable methods of examination.

The Place of Partial Differential Equations in Mathematical Physics: Being a Course of Readership Lectures delivered at Patna University in 1921. By Prof. Ganesh Prasad. Pp. iv+49 (Patna: Patna University, 1924.) n p.

IN the six lectures before us, Prof. Prasad gives an interesting account of the part played by partial differential equations in dealing with vibratory phenomena, conduction of heat, gravitational attractions, electrostatics, magnetostatics, hydrodynamics, electrodynamics and the theory of electrons Since D'Alembert's discovery in 1747 of the equation $\ddot{y}=c^2y''$ arising from the motion of a vibrating string, the study of natural phenomena by mathematical physicists has led them to certain standard types of differential equations. The essential difficulty in finding the solution of such a differential equation lies in fitting it to specified boundary conditions If we have an initial stage of heat given by

$$f(x)=x \text{ for } x>0, f(x)=-x \text{ for } x<0,$$

the first and second differential coefficients are non-existent at the origin and the equation of linear conduction, $\partial v/\partial t=\partial^2 v/\partial x^2$, is meaningless there. An unlimited number of similar cases can be constructed. Though partial differential equations are quite serviceable for most ordinary purposes, in a rigorous treatment they have to be relegated to a secondary place. It is quite possible that at some future time differential equations will appear as but crude instruments and be discarded in favour of the more powerful and more refined integral equations.

Linear Integral Equations. By Prof. W. V. Lovitt. Pp. xiii+253. (New York: McGraw-Hill Book Co., Inc.; London: McGraw Hill Publishing Co., Ltd., 1924.) 15*s.* net.

THE subject of integral equations has been much neglected in university teaching in Great Britain, partly because of the scarcity of text-books suited to the needs of the normal student of mathematics. In addition to a clear exposition of the theory, to carry conviction what the student requires above all is a number of particular examples and applications. The works of Bôcher (1909) in English, Volterra (1913) in French, and Kneser (1922) in German are available but are scarcely in general use.

Prof. Lovitt has produced a very readable book on this very important branch of mathematical study. The discussion, confined to those equations which are linear and in which a single integration occurs, does not deal with equations involving several independent variables, systems of integral equations or integro-differential equations. The author covers, however, in systematic manner the general theory of linear equations, exemplifying the points as they arise by a large number of particular cases and applying the methods to problems in differential equations, the calculus of variations, Neumann's and Dirichlet's problems, and to a series of cases of vibration. There is nothing very new in substance in the book, but it is eminently readable and very well produced.

In the High Himalayas: Sport and Travel in the Rhotang and Baralacha; with some Notes on the Natural History of that Area. By Hugh Whistler. Pp. 223+16 plates. (London: H. F. and G. Witherby, 1924.) 15*s* net.

MR. WHISTLER'S book treats of sport and travel in a remote part of the Himalayan districts of the Punjab, Kulu, Lahul, and Spiti, of which the last is geographically part of Tibet though politically a district of India. The chapters dealing with it are of most interest since the country is almost unknown, but the whole book contains a great deal of valuable geographical and natural history material, including a chapter on birds. There are some fair illustrations and an adequate map.

Ross and Cromarty. By Prof. W. J. Watson. (Cambridge County Geographies.) Pp. xi+140. (Cambridge: At the University Press, 1924.) 3*s.* 6*d.*

PROF. WATSON has added a useful volume to the series of county geographies. The book is especially interesting on the human side, though with commendable restraint his section on the people, race, and dialect occupies only two and a half pages. We notice that he describes the Celts as members of the Nordic race, without actually using that term, and to this stock he attributes some of the fair-haired people of this highland area.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Disintegration of Atomic Nuclei.

SINCE the discovery that high speed protons are emitted from the nuclei of a number of light elements by a close collision with an α particle, it has been a matter of great interest to understand the mechanism of these collisions and particularly the fate of the bombarding α particle. Dr Chadwick and I have shown that the protons are emitted in all directions relative to the bombarding particles, but with greater velocity in the forward direction. This difference of velocity was ascribed to the effect of recoil of the nucleus, and assuming that the law of conservation of momentum, but not of energy, holds in such collisions, we were able to calculate from the experimental data the distribution of momentum between the particle, proton, and nucleus after the collision. These calculations showed that the velocity of the escaping α particle was small for nitrogen, sodium, aluminium, and phosphorus, but considerable for boron and fluorine. Unfortunately, on account of the small number of particles, it is difficult to determine accurately the velocity of the proton in different directions, but, with accurate data, this method should prove useful in throwing light on the distribution of momentum amongst the particles concerned in the collision.

The number of collisions leading to the escape of the proton increases rapidly with the velocity of the impinging α particle, and in the case of aluminium we could observe few, if any, protons when the bombarding α particle had a range less than about 5 cm. The most direct method of studying the results of these collisions is to obtain actual photographs of the tracks of the particles by the well-known cloud method. From the data obtained from our investigations with nitrogen, it seemed probable that about one α particle in 40,000 would liberate a proton when using a source of the swiftest α rays available, namely, thorium-C, which emits particles of range 8·6 cm. in air.

The laborious task of photographing in two perpendicular directions the tracks of about 400,000 α particles was undertaken by Mr. Blackett in the Cavendish Laboratory, using a modification of Shimizu's method. The results of this investigation have been recently published in the Proc. Roy. Soc., 107, p. 349, 1925. In addition to a number of collisions of the α particle with a nitrogen nucleus which obeyed the ordinary laws of an elastic collision, Blackett observed eight forks in all where these laws were not obeyed, and these he ascribed to collisions involving the liberation of a proton. The fine track of the proton was clearly visible, also that of the recoiling nucleus, but there was no sign of a third track to be expected if the α particle escaped after the collision. He concluded that the α particle is captured by the nitrogen nucleus under these conditions, and that in consequence the mass of the recoiling nucleus should be 17 and its charge 8—namely, an isotope of oxygen. He observed that the tracks were coplanar, indicating the conservation of momentum, and found the velocities of the proton and recoiling nucleus to be in fair accord with this assumption. Mr. Blackett hopes to examine in a similar way a number of other active elements to see if a similar process takes place.

It is not my intention here to discuss the bearing of these results on the mechanism of disintegration, but rather to direct attention to other results and suggestions in connexion with this important problem. In 1923, Prof W D. Harkins and R. W. Ryan (Journ. Amer Chem. Soc., 45, p 2095) photographed about 21,000 α ray tracks in air, using the Shimizu method, and amongst other observations recorded a photograph of a collision in which the α ray track broke into three distinct branches—indicating a disintegration in which two high speed particles appear in addition to the recoiling nucleus. My attention has recently been directed to another interesting photograph in air by a similar method, recorded by M. Akiyama (*Jap Journ. Phys.*, 2, p 272, 1923), which also shows three branches The proton in this case is expelled nearly in the backward direction, and two other tracks ascribed to the escaping α particle and recoiling nucleus are clearly visible. It is, of course, difficult to reconcile these photographs with the eight obtained by Blackett in which no third branch has been noted , but it may prove significant that the collisions photographed by Harkins and Akiyama appear to have occurred when the α particle has lost a good deal of its range It is obvious that there is still much work to be done to clear up these difficulties.

In view of the evidence obtained by Blackett of the capture of an α particle, I have thought it of interest to bring to the attention of readers of NATURE two clear statements of the likelihood of such a capture in a collision which leads to the expulsion of a proton In a discussion of a paper on the structure of the atom, read by me before the Solvay International Institute of Physics in 1921 (Rapports et Discussions du Conseil de Physique de Bruxelles, p. 68, published 1923), a reference to this question was made by Prof. J. Perrin. A selection of the remarks made by him will be given in full, as the above publication may not be generally accessible to readers of NATURE:

M Perrin.— . . . " Les expériences mêmes de M. Rutherford semblent prouver qu'il faut renoncer à cette idée d'un simple choc. Le projectile α, en raison de sa grande vitesse, et malgré une très forte répulsion électrique, peut arriver, très ralenti, au voisinage immédiat du noyau A ce moment, une ' transmutation ' se produit, consistant probablement en un réarrangement intranucléaire, avec capture possible du noyau α incident (car nous ne savons pas ce qu'il devient), émission du noyeau d'hydrogen formant le rayon H observé, et peut-être encore avec d'autres projections moins importantes. Il n'y a aucune raison, dans cette façon de voir, pour que le projectile H émis ' se souvienne ' de la direction du choc initial ni pour que son énergie (empruntée pour une part à l'énergie électrique intranucléaire) soit inférieure à celle du projectile incident.

" Si, par exemple, le noyau d'aluminium heurté capture le projectile α et n'émet pas d'électrons, il reste, après l'émission du projectile H, un atome dont la masse est (27 + 4 − 1), soit 30, et dont le numéro d'ordre est (13 + 2 − 1), soit 14, donc un atome isotope du silicium. D'autres hypothèses seraient d'ailleurs faciles."

A suggestion of a similar kind has also been made by Pettersson and Kirsch. They forwarded to me, in June 1924, a short paper intended for publication in which they gave a brief statement of preliminary experiments on the number and nature of the particles liberated from carbon and aluminium at an angle of about 135° with the bombarding α particles. From these data they suggested that the α particle might be captured in collisions in which the proton is liberated. A paper including a statement of their

views on this question was given at the Versammlung Deutscher Naturforscher und Arzte at Innsbruck in August and published in the *Physikalische Zeitschrift* (25, No 22, p 588, 1924)

We must await the results of further detailed experiments to see how far such observations of scattering throw definite light on the problem of the mechanism of a disintegrating collision. It seems clear, however, that a large amount of careful quantitative work as well as a great number of photographs of α ray tracks will be required before we can hope to obtain detailed evidence of the mechanism of such collisions and of the fate of the bombarding α particle for all the " active " elements.

E. RUTHERFORD

Cavendish Laboratory, Cambridge.

The Source of Stellar Energy.

I AM glad to have drawn so interesting a letter from Prof. Eddington as appears in NATURE of March 21. I cannot, however, agree with him that the present position is one of " an almost hopeless deadlock," and neither do I agree with his criticisms of my scheme (NATURE, Feb 28), by which a star consists of a mixture of different types of destructible matter which spontaneously dissolve into radiation at different rates, the rate in each case being unaffected by physical conditions of temperature and pressure. The process imagined by me was in fact analogous to radioactive decay except that the end product is radiation instead of other forms of matter

Prof. Eddington considers that under this scheme the stars would be unstable. A star which in some way increased its rate of generation of energy would expand and this expansion would, he says, lessen the rate at which it was able to radiate its energy away. But why ? The expanded configuration is not one of equilibrium and I cannot see that we have any knowledge as to the corresponding rate of radiation. *A priori* we would certainly expect that the star's first move, when it found too much radiant energy accumulating in its interior, would be in the direction of getting rid of more radiation, not less, as Prof. Eddington asserts. If so, Prof Eddington's argument collapses entirely It may be remarked that if the argument were sound and instability were proved, we could only restore stability by supposing that a decrease in a star's density and temperature *decreased* its spontaneous generation of energy, whereas in actual fact it is the stars of lowest density and of lowest internal temperature which radiate the most energetically

My suggestion that when a star breaks up its ingredients are not fairly distributed between its constituent parts is criticised in the light of some conclusions Prof Eddington has drawn from a certain recently published mathematical theorem May I here merely state that in my opinion this theorem is entirely fallacious ? I hope to justify this statement in print very shortly.

My scheme certainly requires " that the rate of emission of radiation by the star shall be very largely dependent on its previous history." In actual fact considerable ranges of luminosity are shown by stars of identical mass. These I should attribute to differences of birth and previous history, and it may be possible to infer something as to the past histories of the stars from these ranges. Prof. Eddington considers that the observed range is too small, but does he know enough of the past history of different stars to say how large a range ought to be expected ? He discusses two hypothetical stars born originally with masses 12 and 3, but is there any reason for thinking that stars can be born with so great a disparity of mass ? I have, of course, to admit that in time a real difficulty may appear here, but at present its existence is not proven. To my mind the present difficulty lies in precisely the opposite direction ; it is to account for the tendency towards equality of mass which appears in the two components of a binary as its evolution proceeds

I find it difficult to understand the advantages of the hypothesis which Prof. Eddington offers as an alternative to mine. He supposes certain destructible types of matter to be formed at a rate which depends on temperature and density. Their rate of spontaneous dissolution does not depend on the temperature and density at the instant, so that the rate of generation of radiation depends only on the total amount of destructible matter present in the star, which in turn depends on all the temperatures and densities of the past. The radiation, in fact, represents a sort of integral of the past temperatures and densities. As regards stability his stars are in the same position as those of my scheme, while as regards dependence on past history they seem to be worse off.

Any variation, either of creation or destruction of matter, with temperature and density ought almost certainly to be in the direction of higher activity accompanying an *increase* of density and temperature, whereas in actual fact the (internally) hot dense stars radiate little and vice versa. If Prof Eddington insists on any sort of dependence on density and temperature, he must not only, as he says, " admit exhaustion-effects also," but must actually admit more exhaustion-effects than are required by my own hypothesis—unless indeed he can prove that high temperature and density inhibit radiation.

J. H. JEANS.

March 23

Relation of Light to Bird Migration and Developmental Changes.

THAT light is a factor of prime importance in the inauguration or stimulation of bird migration, has been suggested by many authors from the days of Seebohm onwards. While many of the suggestions will not bear close investigation, at least one very attractive view has been put forward by Sir E. Sharpey-Schafer. In an address delivered some years ago to the Scottish Natural History Society [1] he makes the following comments, " . . . the regularity with which migration occurs, indicates that the exciting cause must be regular. There is no yearly change, outside the equatorial zone, that occurs so regularly in point of time as the change in the duration of daylight On this ground this may well be considered a determining factor in migration, and it has the advantage over other suggested factors that it applies to the northerly as well as to the southerly movement." He says further " That it [migration] is a result of developmental changes in the sexual organs is improbable."

Evidently inspired by the work of the botanists Garner and Allard on what they have termed " photoperiodism," an American author [2] has lately revived this theory and has, apparently independently, come to the same conclusion as Sir Edward with regard to the absence of relation between developmental changes in the reproductive organs and migration.

On purely theoretical grounds it has always seemed to me that if the waxing and the waning of the days really in any way affect the migratory impulse, they must produce their effect through the gonads. This

[1] " On the Incidence of Daylight as a determining Factor in Bird Migration," E. A. Schäfer, NATURE, vol. 77, pp 159-163 (December 29, 1907).
[2] " Is Photoperiodism a Factor in the Migration of Birds ? " G. Klein, *Auk*, vol. 41, pp. 439-444.

is not the place for theoretical discussion, and I merely wish to record an experiment that has just reached completion. Other corroborative work is still in progress and a critical histological examination of the experimental and normal material yet remains to be undertaken.

In September of last year I trapped a number of Juncos (*Junco hyemalis*) on their southward migration to the Middle States. These were turned into two large open-air aviaries removed from shelter of any kind. One, into which about a dozen birds were put for the experimental work, was fitted with two 50-watt electric lights. The other housed controls. Commencing on October 2, the lights were turned on at sunset (that is, while the birds were still fully active) and kept on until five minutes after dark. Each day afterwards the time was lengthened by five minutes. Taking into consideration the differences in time of sunrise, the birds thus got about three minutes longer illumination daily On account of the fact that they went to roost at their usual time on the first day in spite of the glaring lights, and that attempts at educating them to keep awake were never wholly successful, and less so with some individuals than with others, it has proved impossible to estimate the effective light increases For the same reason there is lack of uniformity in the results obtained

Elimination of the warmth factor was unexpectedly successful—thanks to a severe winter—the lowest temperature to which the birds were exposed being 50° below zero (Fahrenheit).

Birds were killed at intervals of approximately two weeks, with the following results :

Dates of Killing.	Number Examined.	Size of Testes [a]
Oct 15	1	0·50 × 0 48
(A wild bird killed same date		·60 × ·60) [c]
Oct. 29	1	·44 × ·41
Nov. 13	1	·45 × ·53
Nov. 26	1	·60 × ·44
Dec 11	1	·80 × ·79
Dec. 27 [b]	2	(*A*) ·90 × ? (Part of ribbon destroyed)
		(*B*) 1·80 × 1·54

Catastrophe overtook my control birds and I had to find substitutes. Through the kindness of the Museum of Vertebrate Zoology, University of California, I have been receiving fixed gonads of Juncos (a closely related species of approximately the same size) wintering in the Berkeley district These are not strictly comparable with mine, therefore, but the samples include birds taken at intervals from November to early January. In spite of the California climate, the January testes are minute. My solitary female, killed also on December 27, as compared with the early January females from Berkeley, has an ovary two to two and a half times as large and with conspicuous follicles.

The two males and the female killed on December 27 were kept indoors for their last week at an average temperature of about 40°. (Their drinking water froze one night.) The marked difference in the size of the testes of the two males may probably be accounted for by their habits. *A* went to roost, in spite of the lights (the birds were together in the same cage) about an hour to an hour and a half each night before *B*. The female kept the latter company. *A* sang a good deal ; *B* incessantly All the birds were in excellent condition when killed.

It would, therefore, appear that whatever effect daily increases of illumination may or may not have on migration, they *are* conducive to developmental changes in the sexual organs Comparison of the normal material from Riviera-like California with the experimental product from Alberta further suggests that favourable light conditions are more potent in this respect than favourable temperatures.

WILLIAM ROWAN.

11142 86th Ave., Edmonton, Alta., Canada, January 28.

[a] The whole series of testes was sectioned at 6μ. The first column indicates the greatest diameter of the largest section in each series in millimetres. The second is arrived at by adding the total number of sections for each series and multiplying by 0·006.

[b] The testes of this bird, still on migration, had not yet reached the winter minimum and this accounts for their large size. Diminution in size during the initial stages of the experiment is very marked.

[c] *A* was an adult bird ; *B* a bird of the year.

The Mortality of Plaice.

IT is most valuable to have Dr. Wallace's authoritative opinion (NATURE, March 7) that the scarcity in the North Sea of male plaice more than 8 years old is due to their own physiology and not merely to selective fishing. I suggest, however, to Dr Wallace that this is no evidence of senile death, but of what we may conveniently call *parental* death "The *rapid* decline in the relative number of males just after maturity" (the italics are Dr Wallace's) indicates that death is a consequence of their last and most productive spawning, and Atkinson's Barents Sea Statistics (Table II.) seem explicable only if ♀ of the males there die after first spawning We know that fresh-water eels spawn once and die, the conger also (Cunningham, Journ M B A., vol 2, p. 31) spawns once and dies, and Child ("Senescence and Rejuvenescence," p. 302) states the same of the American salmon, adding, "the organism is undoubtedly in an advanced stage of senescence when sexual maturity is attained" Minot and Child, by the great importance of their work, have permanently changed the meaning of the word "senescence" to signify progressive diminution in rate of metabolism, and they have shown that "senescence" starts at a maximum in the dividing ovum and falls rapidly with advancing age. I would plead that "senility" be still left in its original meaning to designate the negative growth in man which begins after full sexual maturity, and the like phenomenon where it is found to occur in other organisms ; so that we have terms in which it is possible to discuss whether "senility" be really merely the latter stage of "senescence." The death of a fish after spawning in the fulness of its power bears little resemblance to senile death, but is comparable to death of the spore-case when the spores are discharged, or of the wheat-stem when the grain is fallen ; sexual reproduction primitively destroys the parent The whole dividing protozoon disappears and the whole is utilised, but in metazoa a continually larger and more important somatic residue is wasted in death : in the conger, figures cited by Cunningham indicate that the heaviest roes approach to half the total weight, the residual body unutilised being therefore, at the lowest, equal in weight to the matricidal ovaries. So in many groups this loss of capital to the species is gradually avoided ; the spent British salmon succeeds in returning to the sea and building up again in a year or two strength sufficient for a second spawning ; the descendant of annual flowering plants takes on the biennial habit

The hypothesis of potential immortality applies only to those plants and animals (of which, I still suggest, the female plaice may be one) which have completely lost the originally universal liability to parental death and have become perennial; and botanical

friends tell me that they know no evidence of senility in perennial root-stocks or 5000-year-old trees. My suggestion is that we have no evidence of senility in the female plaice, and that senility is not an inherent quality of protoplasm, but the consequence of a mechanism for the preservation of specific size. The plaice has no specific size, and therefore, when in the female growth is not ended by parental death, no mechanism for the limitation of growth is evolved and there is no senility

Among animals which produce numerous young there is more reason for the female to attain the perennial habit than for the male, since a female plaice must grow for many years before she is large enough to produce as many ova as one eight-year-old male can fertilise. Even human curves of growth and senility indicate that in these aspects the male and the female are different animals. Looking at other groups, it becomes clear that no conclusion as to the gradient of life in one sex can be formed from observation of the incidence of death in the other: the queen-bee's life-history bears little relation to that of a drone, the longevity of the female spider is not measured by that of the consort she devours, and the female barnacle, *Scalpellum ornatum*, is associated with a succession of short-lived epizoic males.

I suggest to Dr. Wallace that we have as yet no evidence of senility in plaice, but of parental death for the North Sea male on perhaps the third spawning, at a body-weight of some 700 grams. There is an unproved possibility of parental death for the female on reaching some very much larger size at which her ovaries would bear a lethal ratio to her body-weight; this we may guess, on the analogy of the conger, might be when the ovaries form about one-half the total weight. If the ratio of ovary-weight to body-weight continue to increase according to the formula $y = x^k/400$ (NATURE, January 31, p. 155), the ovaries would be one-half the weight when the plaice attains 6000 grams if $k = 1{\cdot}61$, and when it weighs 16,000 grams if $k = 1{\cdot}55$. (The largest plaice recorded, *fide* Cole and Johnstone, weighed 6800 grams.) If, on the other hand, as the fish grows larger k diminishes, and reaches 1·0 at a constant ratio of ovary-weight to body-weight which allows the residual body to recover after spawning, then the female plaice has lost liability to parental death, while it has assumed neither specific size nor the senile death which is its consequence.

GEO. P. BIDDER.

Cambridge, March 12

The Propagation of Radio Waves over the Earth.

IN NATURE of March 7 there are two letters dealing with the subject of the transmission of electric waves over the earth's surface. Prof. Appleton has given some results which indicate that very marked interference effects occur at night. So far as I understand, he has suggested an interpretation of the experimental results in terms of the simple theory in which the maxima and minima of received intensity are supposed due to the interference of a direct ray over the surface of the earth, and a single reflected ray, passing from the earth to the Heaviside layer and back to the receiver. But the problem is scarcely so simple as this, for the multiple reflection may occur, the ray passing many times between the earth and upper layer before reaching the receiver. Such an effect would obscure the main results if the intensity of these rays were of the same order as those of the direct ray.

About a year ago I made a mathematical investigation of the case, where the bounding surfaces are assumed to be plane; the results obtained are of interest in connexion with the present problem.

Very briefly, the electric force at the receiver due to a current I in a transmitter of effective height (h) situated on the lower of the two surfaces consists of the direct wave:

$$\text{i.e.} \qquad \frac{120\pi hI}{\lambda x}\cos\left(\frac{2\pi}{\lambda}x - pt\right),$$

together with a finite number s of terms of the form

$$\frac{120\pi hI\sqrt{1-\beta_m^2}}{2H\sqrt{\lambda x}}\cdot\cos\left(\frac{2\pi x}{\lambda}\sqrt{1-\beta_m^2} - pt + \frac{\pi}{4}\right),$$

where s is the nearest integer less than $2H/\lambda$, and H is the height of the layer, λ the wave-length of the transmitted wave, x the distance, and

$$\beta_m = \frac{(s-m)\lambda}{2H},$$

m being an integer which varies from zero up to s. These terms represent a series of progressive waves which travel to and fro between the upper and lower surfaces along rays which are inclined at angles θ_m to the earth's surface where $\sin\theta_m = \beta_m$.

Together with these there are a series of stationary wave terms which are unimportant compared with the progressive waves at distances large compared with the height of the Heaviside layer.

The effect of resistance in the bounding layers is to introduce an attenuation factor in each of these terms of the form $E^{-\alpha s/\sqrt{\lambda}}$ and to modify the intensity only to a second order amount.

The state of affairs in the space between the two layers is very complex, especially when a wave-length is used which is very small compared with the height. The object of this letter is to point out the conditions under which the simple theory is applicable, and also to show how these mathematical results may be used to determine the height of the Heaviside layer in the daytime, a determination which is beyond the scope of Prof Appleton's experiment, since the interference effects with which he deals do not occur in the daytime.

With regard to the first question, I agree with Prof. Appleton that there is evidence that the bounding surface of the upper conducting layer is not sharply defined, and that there must be a more or less gradual transition This would favour the reflection at glancing incidence compared with that at normal or nearly normal incidence.

If, then, the receiver were fairly close to the transmitter so that the distance between them were of the same order as H, multiple reflections might not occur, and the results might be explained by the simple theory; but the fact that fading effects as well as directional variations have been observed so close as twenty miles from the transmitter, shows that high angle reflections must not be entirely neglected. Experiments must decide whether they are or are not of importance in Prof. Appleton's case.

With regard to daytime transmission, I think that in spite of the fact that there are no signs of interference phenomena, transmission on long wave-lengths, and as recently shown, on very short wave-lengths, must be effected by the help of an upper layer, which for long waves acts as a pure conductor and for very short waves as a refracting medium with ionic dispersion.

This view is upheld by the results of a large number of measurements made during the past three years, the results of which will be published shortly in a paper before the Institution of Electrical Engineers. These indicate that for transmission on waves longer than

about 5000 metres, diffraction alone is wholly inadequate to account for the signals obtained.

If now we assume the presence of some reflecting or refracting layer, the foregoing mathematical theory can be applied at a distance large compared with H, but small relatively to the earth's radius, so that the curvature can be neglected.

In actual practice the interference between the large number of terms postulated by the theory is not present, and this may be accounted for by assuming that the layer is a good reflector only for glancing incidence, in this case it can be shown that only the zero order term remains (with $m = s$, $\beta_s = 0$),

$$i.e. \qquad \frac{120\pi hI}{2H\sqrt{\lambda x}} E^{-\alpha x/\sqrt{\lambda}}$$

apart from the direct wave, which, varying inversely as the distance, is negligible at greater distances than a few hundred kilometres

Now the experimental results show that the observed signal strength E can be expressed very well by a formula of this type in which the value of H is approximately 40 km This must be regarded as only an equivalent value since the lower surface of the layer is probably very ill-defined. T. L. ECKERSLEY.

Marconi's Wireless Telegraph Co., Ltd.,
Chelmsford, March 20

The Absorption of Cathode Rays in Aluminium.

IN a recent paper in the *Physical Review* (December 1924), H M Terrill gives some measurements of the variation in the fraction of a beam of cathode rays transmitted by an aluminium foil when the velocity of the rays is varied. These results are not in agreement with those published by me (Proc Roy. Soc A, vol. 104, 1923), and the author states that "Whiddington, and later Schonland, worked with rays of uniform velocity produced by magnetic sorting, but the results obtained by them are not in agreement with each other nor with those of the earlier writers. It is believed that the lack of agreement in these results may be traced to the difficulties of velocity determination."

This is scarcely correct. A variety of causes rendered the work of the earlier writers unsatisfactory from a quantitative point of view, while the experiments of Whiddington suffered from an important defect, for no precautions were taken against the disturbing effect of the emission of secondary rays from the foil. My apparatus was designed to remove this source of error, and when allowance is made for the secondary emission, Whiddington's results are in satisfactory agreement with my own.

Dr. Terrill's explanation of the difference between his results and mine would require a correction to my values of $H\rho$ amounting to about 20 per cent., while I am certain that they are not at fault by more than 2 per cent., the measurements having been repeated with a new and differently wound solenoid

That the difference is, however, not due to this cause at all but to the experimental arrangement for measuring the fraction transmitted, is shown by the fact that our results for the velocity of those rays which are just unable to penetrate the foil (the "Range" velocity) are in close agreement. Thus, for a foil 0·00031 cm. thick he finds 19,000 volts, and I, 19,500 volts for the P.D. corresponding to this velocity. This indicates that my velocity measurements are substantially correct and that the differences between our results arise from errors in the measurement of the fraction transmitted.

I believe that Dr. Terrill's arrangement for this purpose is open to criticism, principally owing to the method adopted to prevent the emission of secondary rays from the foil, but also to the fact that so small a fraction (< 1/1000) of the cathode ray beam was employed in the actual measurements. I have had experience of both these causes of error and found them to be very serious.

B F. J. SCHONLAND.

University of Cape Town,
February 18.

Adsorption of Acids by Purified Silica.

IN the issue of NATURE for January 31, p 157, it has been stated that hydrated silica free from all impurities adsorbs acids The amounts adsorbed by these samples are, however, small. We have since found that if thoroughly washed hydrated silica prepared from pure silicon tetrachloride be allowed to be partially dehydrated in air at room temperature, it shows a marked increase in its capacity to adsorb acids, as the following data will show

Electrolyte.	Concentration	Amount of Adsorption per 10 grams of Hydrated Silica
Oxalic acid	N/2	46 0 c c of N/10 solution
	N/10	7 5 " " "
	N/50	1 0 " " "
Potassium oxalate	N/2	45 0 " " "
	N/10	7 5 " " "
	N/50	1 0 " " "
Sodium oxalate	N/10	7 5 " " "
	N/50	1 0 " " "
Hydrochloric acid	N/2 (F 1 08)	42 0 " " "

The samples are free from all impurities At equivalent concentrations, neutral oxalates and oxalic acid show equal adsorption of the oxalate ion, which, together with the increase in the negative charge of the silica in contact with solutions of neutral salts of low concentrations, proves that we are dealing with anion adsorption as suggested by the writer to account for the latent acidity of sour soils. The large amounts of acids adsorbed leave no doubt that Joseph and Hancock were mistaken in stating that purified silica cannot adsorb acids That they could not observe any adsorption of acids by silica was due to their using ignited silica, as we have found that on ignition the power of silica to adsorb acids greatly diminishes.

In my previous letter referred to above, a mistake occurs (page 158) in the P_H value for the acidity developed on interaction between barium chloride and potassium sulphate. The value given was 2, whereas it should have been 5

J. N. MUKHERJEE.

University College of Science,
Calcutta

Method of Measuring Deep Sea Tides.

IN the course of a conversation with William Beebe regarding plans for work to be done on his oceanic expedition, my attention was directed to the fact that no method had been devised up to the present time for recording the rise and fall of the tides except in comparatively shallow waters. It appeared that the Hydrographic Office was very anxious to have data regarding the tides at localities where the depth of the ocean was measured in miles.

The problem looked rather hopeless at first sight, but on thinking about it, the idea occurred to me that if we could make an artificial island, reaching up from the sea floor to within a few feet of the surface, the rest would be easy. Such an island could be made by means of a submerged buoy

anchored to the sea bottom by a wire. If the ocean were calm, and there were no currents, this buoy would remain in a fixed vertical position above its cement anchor at a constant distance from the ocean floor. If the buoy contained a self-recording barograph of special design operated by the pressure of the water above the buoy, the periodic rise and fall of the tide would be recorded.

Other factors might, and probably would, be present which would cause a variation in the height of the water above the buoy. Ocean currents, by causing the buoy to swing out from the vertical, would depress it, and there would of course be a rapid periodic change due to waves. It seems probable, however, that if the curve drawn on the revolving drum of the barograph was subjected to analysis by passing it through such a machine as Prof. Michelson's harmonic analyser, the tide curve would come out uncontaminated by the variations contributed in other ways.

The scheme could be tried at very small cost. The first experiments should be made in comparatively shallow water (say three or four hundred feet), and the depth gradually increased. For deep sea work the position of the submerged buoy would have to be marked by a smaller surface buoy. The action of the wind on this would introduce another disturbing factor, which would disappear, however, in the analysis of the curve.

R. W. WOOD

Johns Hopkins University, Baltimore.

Electricity in Curved Space-time.

It is often thought that the theory of curved space-time (general relativity theory) accounts for gravitation but *does not account for the electromagnetic phenomena*. This is not so.

In the general four-dimensional space, the Riemann tensor which characterises the curvature at each point can be shown to be the sum of two parts. We may characterise these two parts geometrically, using Hamilton's device of telling what a thing is by telling what it does. What a Riemann tensor does is to assign to every two-dimensional direction, or orientation, a certain number—its curvature; the first of the two parts mentioned above is characterised by the property that it assigns to two (absolutely) perpendicular orientations *equal* curvatures, while the second part assigns to such orientations *opposite* curvatures. We may mention that of the twenty constants which are needed to give the complete Riemann tensor, the first part involves 11 and the second 9.

In the case of the physical space-time, the first part accounts for gravitational phenomena and the second for electromagnetism, we do not know much about the first part outside the fact that it satisfies the so-called cosmological equations (in fact, to say that a Riemann tensor satisfies the cosmological equations is equivalent to the statement that it only consists of the first part). Our information with respect to the second part is much more complete: if f_{ij} is the electromagnetic tensor and r_{ij} the tensor associated with its reciprocal or dual, the second part can be written as $\frac{1}{2}(f_{ij}f_{kp} - r_{ij}r_{kp})$; conversely, if the second part is given in a region of space-time, this determines the electromagnetic tensor in this region. This result follows easily from an earlier work of the writer (Proc. Nat. Acad. of Sciences, April and July 1924; Trans. Amer. Math. Soc., January 1925).

G. Y. RAINICH.

The Johns Hopkins University,
Baltimore, Md., U.S.A.,
February 20.

Artificial Incubation.

In the account of Mr. Llewelyn B. Atkinson's article on "The Scientific Principles of Artificial Incubation" (NATURE, February 21, p. 282), the author is quoted as saying that practically every type of incubator has the air too dry. If this is so, the number of eggs hatched should be dependent to some extent on the humidity of the outside air. That this is the case is we think borne out by the following. We took the percentages of fertile eggs hatched out at Fishponds Poultry Farm, Netley Abbey, and correlated the figures with the relative humidity deduced from the dry and wet bulb readings at Calshot, four and a half miles distant. The hatchings considered were from December 17, 1923, to March 12, 1924, there were hatchings on 26 days; the largest number of eggs hatched out on any one day was 95, the smallest two 37 and 60, the highest percentage of fertile eggs hatched on any one day was 93·2, the lowest 63·5. The readings at Calshot are those taken four times in the twenty-four hours, and we have taken them from the Daily Weather Report. The following values were found for the correlation coefficient between the percentages of hatchings and the mean relative humidity for various periods:

	Day of Hatching.	7 Previous Days.	14 Previous Days	21 Previous Days
Correlation coefficient .	0·31	0·55	0·69	0·68
Standard error .	0·18	0·14	0·10	0·11

It seems, therefore, that the hatchings were dependent to some extent on the mean relative humidity of the outside air during the greater part of the period of incubation.

C. J. P. CAVE
T. VERNON JONES.

Stoner Hill, Petersfield,
March 12.

Solutrean Art.

PROF. SOLLAS, in his letter to NATURE, March 21, p. 420, refers to M. Peyrony's interesting discovery of a carving in high relief in a Solutrean level in the Dordogne. In this connexion it is worth noting that, some months before M. Peyrony's discovery, Dr. Henri Martin had found fragments of limestone bearing engravings of animals in an Upper Solutrean site (still unpublished) in the Charente.

These two finds, so nearly simultaneous, are very important, as Prof. Sollas points out, but it is only fair to recall the fact, apparently overlooked both by M. Peyrony and Dr. Martin, that the credit of being the first to find a work of art in an undoubted Solutrean milieu belongs, not to either of them, but to the Abbés A. and J. Bouyssonie and L. Bardon, who in 1908 found in the Upper Solutrean level of the rock-shelter Pré-Aubert near Brive a slab of sandstone engraved with the rough but unmistakable figure of a horse (*Revue anthropologique*, 1920, p. 188.)

At a moment when discoveries of Solutrean art are exciting great interest both in Great Britain and in France, it is merely just that full credit should be given to the three indefatigable scientists whose work, so little advertised, has been of such fundamental importance to prehistoric archæology.

D. A. E. GARROD.

85 Banbury Rd.,
Oxford.

Mutation.[1]

By Prof. R. RUGGLES GATES.

THE term mutation in the modern sense means a discontinuous germinal change. Conceptions of continuity or discontinuity have played an important rôle in the history of thought not only in biology, but also in other sciences, notably physics and geology. In the latter science the earlier and cruder theories of catastrophism, in which the sudden extinction of floras and faunas was followed by the creation of new ones, were superseded by the uniformitarianism of Lyell. This, coupled with the slow and gradual modification of species as upheld by Darwin, led to a complete triumph of "continuity." But with the followers of Darwin it frequently reached an extreme expression which was not in accordance with the facts of biological variation It was thought that variations which were often spoken of as infinitesimal, could be accumulated in any direction to produce new species. But to produce a new species by this method, such accumulation of infinitesimals must take place simultaneously in several diverse directions, for species differ from each other in a number of independent characters.

Neither Darwin himself nor Wallace ever contemplated infinitesimal variations as a source of new species. Darwin was at pains to show that the gaps between species or varieties could frequently be bridged by intermediate steps, but he was too widely observant of actual variations in plants and animals to make the mistake of assuming complete continuity in all variation. The innumerable cases of variation which he cites in the "Origin" and the "Animals and Plants" usually concern differences which are relatively large compared with many which we now cite and study as discontinuities. The mutations of Drosophila, for example, such as the eye colour series, represent differences which are smaller than anything upon which Darwin relied for the origin of new forms. When all these eye colours are placed together they represent so close a series that to the average naturalist they appear to show complete continuity even under the microscope; and even the expert can scarcely sort all the individuals belonging to the different types in this series with certainty. Yet we know that they arise as marked discontinuities and not as steps in a consecutive series. They are moreover independently inherited, belonging often to quite independent groups of characters

Biological controversy on this subject has oscillated somewhat like a pendulum gradually coming to rest. Each time the upholders of continuity have pointed out an apparently continuous series, their opponents have replied by showing progressively smaller discontinuities within the series. Waagen, Korschinsky, Bateson, W. B. Scott, de Vries, Morgan and others have taken part in this controversy.

Continuity or discontinuity is then a purely relative matter. Series of variations which Darwin and his contemporaries would have regarded as showing complete continuity biologists of this generation have shown by breeding experiments to be inherited as independent units. The essential point is not whether the series appears continuous or not, but whether the differences depend on fixed inherited units. Two series of variations may overlap so as to appear like a single continuous series and yet may depend upon two independent units of inheritance.

When we touch modern physics discontinuity appears everywhere. To the senses matter is continuous, but no scientific man doubts the atomic and molecular, that is, the discontinuous, structure of matter. The atom itself, once regarded as an ultimate unit, is now decomposed into electrons with definite orbits revolving about a nucleus, the analysis of which into protons and electrons has only just begun. Planck's theory of quanta of energy or action extends discontinuity from matter into the field of energetics, and even radiation is now considered as a discontinuous process. Sir Oliver Lodge, in his presidential address to the British Association at Birmingham in 1913, said, "So far from nature not making jumps, it becomes doubtful if she does anything else." Even the ether of space is not retained as a continuum to serve as a background for these physical events. It cannot be adequately used in physical theory except by giving it a granular, that is, a discontinuous structure.

I refer to these similarities in the history of physics and biology, to show that discontinuity is a philosophical necessity in scientific analysis. The mere process of analysis of any structure, however large or small, whether it be a star, a chromosome or an atom, endows it with parts which have relations with each other and are more or less disconnected.

The real problem for the biologist is, then, to determine whether his units in the study of variation are rightly chosen, so that the laws of their inheritance can be followed. In the modern point of view, variations are of two sorts: (1) mutations, which form a new point of departure and are inherited, and (2) fluctuations, which are merely deviations grouped on either side of the mean, produced by environmental or nutritional disturbances and not inherited. This distinction we owe to de Vries, whose "Mutation Theory," first published in 1901, marked, together with the rediscovery of Mendelism, the beginning of a new era in the study of evolution

Before outlining the theory of mutation, in the later development of which my own work has played some part, I wish to refer briefly to a few of the earlier observations and theories of discontinuity in variation. The earliest actual mutation recorded is that of *Chelidonium laciniatum* Miller, a subspecies derived from *C. majus* Linn. the common celandine, a monotypic genus of the poppy family. This laciniate variety was found by an apothecary named Sprenger growing in his herb garden at Heidelberg, about 1590, among typical plants. It was new and unknown to the botanists of his time; it bred true from seeds and has continued to do so ever since. It differs from the type in having laciniate petals and leaves. Such variations are by no means uncommon, the cut-leaved varieties of many trees such as the birch, etc., being of this character.

We need not pause here to consider whether the laciniation first arose at the time when it became

[1] From a lecture delivered at King's College, University of London, for the Board of Studies on the History, Principles and Methods of Science.

externally visible or whether it had been carried germinally as a recessive condition for some previous time. Nor need we probe here the question whether the germinal change involved arose in a pure line or in a line the ancestors of which had been derived from the intercrossing of distinct types within the species Something distinct and new has declared itself, and we call it a mutation, recognising that further analysis will throw much light on the precise manner of its origin, that is, the nature of the germinal change involved.

The conception of discontinuity in evolution did not originate with de Vries, although he was the first to investigate it by experimental methods. Without tracing its sources in biology, its modern emphasis began with Bateson, whose "Materials for the Study of Variation," in 1894, marked a reaction from the morphological problems then current in zoology and from the post-Darwinian attempts to explain evolution entirely through the accumulation of infinitesimal variations by natural selection Bateson's subsequent development of Mendelian theory has been a continuation of views there set forth

Another work which had an important effect, especially on botanical thought, was the "Intracellular Pangenesis" of de Vries, first published in 1889. The views there expressed were themselves derived from the development and modification of Darwin's provisional hypothesis of pangenesis, set forth in the last chapter but one of the "Variation of Animals and Plants under Domestication." This hypothesis of representative particles or gemmules assumed that every cell of the body is represented by particles which multiply by division as the organism develops. These particles (1) not only grow and multiply and are thrown off from the cells, but (2) they "aggregate themselves into buds and the sexual elements," by this means transmitting their qualities to the next generation. The hypothesis of de Vries discarded the second part of Darwin's hypothesis (which Darwin had introduced to account for the assumed inheritance of acquired characters) while limiting the first part, so that pangens were not extruded from the cells but controlled the development of a cell by passing from its nucleus into the surrounding cytoplasm

Both Strasburger in cytology and Pfeffer in plant physiology adopted the term and the conception. The necessity for some such conception to account for the phenomena of development and heredity has been felt by many other physiologists, such as Verworn with his biogens Physiologists who deny the necessity for such a conception have not occupied themselves seriously with the study of heredity. Chromosome division in mitosis must itself be looked upon as an hereditary process—an essential act of reproduction—and the chromosome as a body composed of autogenetic substances which show alternately the phenomena of growth or multiplication and division. The chromosome, as the most conservative body in the cell, thus makes possible the phenomena of heredity. The autogenetic particles which it is assumed to contain tend with increasing knowledge to lose their "representative" character and to become more purely chemical aggregations.

The whole history of the many conceptions of biological units furnishes but another example of the necessity for discontinuity in scientific analysis. The modern gene or factor, which is essential to the explanation of Mendelian heredity and mutation, is the same particle under another guise, the properties and modes of action of which are gradually becoming more precisely defined. Each such gene may have come into existence through the alteration of a previous element, and not necessarily through the loss or gain of a "particle." The philosophical necessity which Darwin himself felt, and which was the *raison d'être* of his hypothesis of pangenesis, has been followed by a long historical chain of representative particles, such as the ids and biophores of Weismann, down to the modern gene, which has been stripped of some of its mystery but is still essential for an explanation of the phenomena of heredity and variation.

In the original work of de Vries with *Oenothera Lamarckiana*, a number of new forms or mutations were described as arising, which usually differed from the parent in a number of features. Later cytological investigations, beginning in 1906, made it clear that the origin of many of these new types was concerned with changes in the number of chromosomes. This finally led to the formulation of the cell theory of mutation,[2] in which it was indicated that Mendelian mutants, such as *Oe brevistylis* and *Oe. rubricalyx*, had arisen as the result of a change in one element or gene of a chromosome, while such mutants as *lata* and *incurvata*, which possessed an extra chromosome, had appeared in connexion with an irregular reduction division of the chromosomes in the parent Since the extra chromosome was found in every cell nucleus, the conclusion was clear that a mutation represented a germinal change which was transmitted by mitosis to every cell. This point of view has been strengthened by many subsequent discoveries A whole series of Oenothera mutations with 15 chromosomes is now known.[3]

The origin of the mutant *Oe. gigas* involved still a different type of germinal change, for in this case the chromosome number was doubled (28). This was the first instance in which tetraploidy was shown to occur under experimental conditions. *Oe. gigas* is so distinct from *Oe. Lamarckiana* in all its characters that if found wild it would undoubtedly be described by systematists as a new species. There is even a conspicuous change in the shape of the pollen grains. Polyploidy, or the multiplication of the chromosome series, is now known to have played a part in the evolution of many plant genera.[4]

Another conception based upon the discoveries with Oenothera is that of parallel mutations. It was shown originally in 1912 that *Oe. biennis* can produce a *lata* mutation having the foliage peculiarities, sterile pollen and 15 chromosomes of the *lata* derived from *Oe. Lamarckiana*, but having the small flowers of its parent *Oe. biennis*. Innumerable cases of such parallel mutations are now known,[5] and the principle is bound to play an important part in the future interpretation of phylogenies.

Many other developments in the theory of mutation have occurred since 1901. The experimental work with Mendelism and mutations has shown that these two fields of research are fundamentally in harmony and can be further developed under a common point of view.

[2] Gates, "The Mutation Factor in Evolution," 1915
[3] Gates, "The Trisomic Mutations of Oenothera," *Ann. of Bot.*, vol. 37, p. 543, 1924.
[4] "Polyploidy." *Brit. Journ. Exptl. Biol.*, 1, 153-182, 1924.
[5] See for example Gates, "Mutations and Evolution," 1921.

The Manufacture of Blue Water Gas.

THE manufacture of water gas first became an industrial proposition in 1873 with the introduction of the intermittent system by Strong and by Lowe in the United States. Strong, who aimed at manufacturing blue water gas mainly for heating purposes, utilised the heat value of the "blow" gases to superheat the steam admitted to the generator. Lowe, on the other hand, aimed at producing a gas of high illuminating value, and utilised the large quantities of combustible gas produced during the "blow" periods for heating chambers in which enriching oil was decomposed. No real progress in the manufacture of water gas in Great Britain was made until 1888, when a plant was installed at the Leeds Forge Since that time the utilisation of water gas has advanced rapidly, and the manufacture of water gas, both blue and carburetted, is now an important auxiliary in the production of gas for town supply.

The blue water gas process, according to general British practice, may conveniently be divided into two distinct operations. The hot fuel, usually coke, is first raised to a high temperature by the admission of air at such velocity that the pressure below the generator grate is 12 to 18 inches water-gauge This operation, known as the "blow," occupies from one to three minutes. The gases produced are blown away to the atmosphere through the stack, either directly or after combination with air and passage through a waste heat boiler When the temperature of the coke has been raised to the required degree, the air supply is closed, and the bed of fuel is submitted to the action of steam supplied at a measured rate. The steaming operation, which is known as the "run," occupies from four to ten minutes according to the cycle of operations adopted. The blow and run operations are carried out alternately during a period of several hours, at the end of which the operations are suspended for the removal of ash unless mechanical grates are provided.

BLOW PERIOD.—The addition of heat to the bed of fuel during the blow period results mainly from that developed by the oxidation of carbon to carbon monoxide and carbon dioxide, and provided other conditions remained unchanged, the degree of heat addition would be dependent on the proportion in which these two gases are produced. The principal reactions which take place may be represented by the equations:

$$(1)\quad C + O_2 = CO_2 + 97{\cdot}3 \text{ Cal.}$$
$$(2)\quad C + \tfrac{1}{2}O_2 = CO + 29{\cdot}0 \text{ Cal.}$$

The aim during the air-blow should therefore be to obtain the maximum amount of carbon dioxide and the minimum of carbon monoxide. The first reaction predominates at lower temperatures and the second at higher temperatures. The efficiency of heat generation therefore decreases with rise of temperature.

RUN PERIOD.—When steam is passed over incandescent coke, of the reactions which occur, consideration should be given to the following:

$$(3)\quad C + H_2O = CO + H_2 \textit{ minus } 29 \text{ Cal.}$$
$$(4)\quad C + 2H_2O = CO_2 + 2H_2 \textit{ minus } 19 \text{ Cal.}$$

At temperatures above 1000° C., the products of reaction of steam and carbon are almost entirely carbon monoxide and hydrogen. At lower temperatures the importance of reaction (4) increases, and the proportion of steam decomposed decreases.

From consideration of the reactions which take place in the intermittent process of manufacture of water gas, it is clear that in order to obtain high efficiency of heat addition during the air-blow, the fuel must be kept at a comparatively low temperature, and the time of contact of the gases with the hot fuel must be small. On the other hand, to obtain a high efficiency during the steaming operation, the fuel should be kept at a high temperature, and a longer time of contact must be allowed. It is evident, therefore, that these opposing factors must be taken into account in determining the conditions of best efficiency for the whole process.

During recent years, the large scale production of water gas has been the subject of investigations by a Research Committee of the University of Leeds and the Institution of Gas Engineers, and by the Fuel Research Board. From the data procured, thermal balances were constructed. As an example of a thermal balance under conditions typical of British practice, the following is taken from the tenth report of the Research Committee of the Institution of Gas Engineers:

HEAT BALANCES IN THERMS PER 1000 CUB. FT. WATER GAS MADE.

Heat supplied—		
(*a*) Coke to generator		4·900
(*b*) Fuel to raise steam to generator		0·551
(*c*) ,, ,, ,, turbine		0 643
(*d*) Sensible heat of air to blower	Minus	0·001
		6·093
Accounted for as follows—		
1. Water gas, potential heat		2·960
2. ,, ,, sensible heat		0·171
3. Steam not decomposed (total heat)		0·163
4. Blow gas, potential heat		1 042
5. ,, ,, sensible heat		0 462
6. Heat lost in raising steam to generator		0·165
7. ,, ,, ,, ,, turbine		0·193
8. Heat of steam used and lost in turbine and blower		0·446
9. Ashes, potential heat		0·207
10 Clinker ,, ,,		0·017
11. Dust ,, ,,		0·070
12. Ashes, clinker, and dust, sensible heat		0·020
13. Losses, not separately determined, leakages, radiation, convection, etc (difference)		0 177
		6·093

In a paper presented a short time ago to the Institution of Chemical Engineers, Dr. M. W. Travers has studied the results of the investigations previously mentioned Dr. Travers is of the opinion that in addition to thermal balances of the type illustrated, thermal accounts should be constructed to show the amounts of heat added to the fuel during the blow periods and abstracted during the steaming operations. These two amounts of heat should be identical provided that the whole of the necessary data is available with a high

degree of accuracy. The problem, however, is complex, and many other factors in addition to the main carbon-oxygen and carbon-steam reactions must be considered. The coke supplied to the generator invariably contains moisture, hydrogen, sulphur, nitrogen, and ash, and these constituents take part in a number of reactions which cannot be neglected. The amount of water vapour in the air supplied to the generator also has an important effect on the heat account. Separate thermal accounts for the "blow" and "run" periods would undoubtedly be of value, but further study of the subject is required before these can be constructed with sufficient accuracy to enable trustworthy conclusions to be drawn. A. PARKER.

Obituary.

PROF. AXEL WIRÉN.

THE death of Prof Axel Wirén of Upsala has deprived zoology of an able original worker and a distinguished teacher in the University of Upsala. Born on July 12, 1860, in Eskilstuna on the western or landward side of the province of Sodermau Land, about 50 miles west of Stockholm, and the eastern border of which (province) reached the sea, Wirén received his early education at the school of Norrköping, in which his matriculation examination also took place, and he afterwards entered the University of Upsala, where he graduated as Ph.D. in 1885, his thesis being on the circulatory and digestive organs of certain families of polychæts.

From the first the young graduate was attracted to marine zoology and at a time when several departments were sorely in need of scientific advancement. He set himself to work up the zoology of Upsala, especially the chætopods, and by and by he published a series of important researches in the Kongl. Svensk. Vetersk.-Akad. Handl., all finely illustrated by his artistic pencil, the plates varying in number from 5 to 10 (4to) in each communication. The accuracy and beauty of these plates and the value of the accompanying researches would alone have given him a solid reputation. They dealt chiefly with the circulatory and digestive organs of the polychæts, though the minute anatomy of the solenogastres was also worked out with conspicuous ability. Amongst his interesting novelties was the discovery of *Hæmatocleptis terebellidis*, a parasitic eunicid living in the wall of the chitinous stomach of *Terebellides Strœmi*—just as Spengel had found another polychæt, *Oligognathus Bonelliæ*, in the cœlom of Bonellia. Besides other papers he published one on *Nereilepas fucata* in its atokous and its epitokous forms, and the changes in its body-wall, as well as a work on the elements of zoology, a useful treatise for his students. He also gave an account of a visit he made to the museums and zoological institutes of Germany in 1891.

Besides his own strenuous labours in upholding zoology at Upsala—mindful of his responsibilities—Wirén encouraged the young graduates and others to carry on original work in his department, and exerted himself in founding the zoological institute of the University from which many important memoirs were issued. These were published in the series of the "Zoologiska Bidrag från Uppsala" (large 8vo), edited by Prof. Wirén. The perusal of these fine memoirs (the expense of which was partly defrayed by the generosity of the late consul, R. Bünsow) raises a feeling of regret that, in a great country like Britain, zoological institutes on the sea beach should be closed for lack of men, interest, and money, instead of continuing the fascinating researches in marine zoology and botany—not to allude to the importance of these in connexion with the fisheries.

Prof. Wirén was elected to the chair of comparative anatomy at Upsala in 1893, after holding various minor posts. He became professor of zoology and Director of the Zoological Institute in 1908, and held these offices until his death on January 22 last. He worthily served his country and science.

W. C. MCINTOSH.

MR. W. H FINLAY.

A CORRESPONDENT at Cape Town sends us some particulars of the life and work of Mr. William Henry Finlay, formerly chief assistant in the Royal Observatory, Cape Town, who died there on December 7, 1924. Mr. Finlay was born at Liverpool on June 17, 1849, and educated at Liverpool College School. He proceeded to Trinity College, Cambridge, graduating 33rd Wrangler in 1873. In the same year he was appointed first assistant at the Cape Observatory, when Mr. Stone, who succeeded Sir Thomas Maclear, was H.M. Astronomer. Mr. Stone's directorate is chiefly remarkable for the enormous amount of arrear reductions of transit observations which he accomplished, and for his well-known 1880 Cape Catalogue of Stars. In all this work Mr. Finlay took his full share.

As an observer, Mr. Finlay was very zealous in the observation of comets and occultations of stars. He independently discovered the great comet of 1882, and also one, which bears his name, in 1886, and undertook the difficult task of computing its elements as well as of many another. Perhaps in astronomical circles he will be best remembered by his excellent Star Correction Tables, which exemplify the clear grasp he had of his subject, and the orderly practical habit of his mathematical mind.

In addition to his purely astronomical work, Mr. Finlay took an active part in the geodetic work which Sir David Gill, who succeeded Mr. Stone, undertook during his famous directorate. He took the principal share in the longitude operations for connecting Aden with Cape Town, and on his voyages to and from Aden he took advantage of the short stoppages of the steamer at Delagoa Bay, Quilimane, Mozambique, and Zanzibar to determine local time at these places with portable instruments, and to exchange time signals with Cape Town. These observations and the resulting longitudes were published in the Monthly Notices of the Royal Astronomical Society.

In 1887 Mr. Finlay undertook the discussion of the tidal records of Table Bay and Algoa Bay, and the result of his analysis, which is published in the Journal of the South African Philosophical Society, is still the

basis for all tidal predictions at those ports. In addition to these activities, he became the general secretary of the Society from 1881 to 1887, in which year he was elected president. He was also a member of the Cape Meteorological Commission.

When the staff of the Royal Observatory was reorganised in 1897, Mr. Finlay was appointed the chief assistant, but owing to ill-health he was obliged to retire on pension the following year. He spent several years in England, where he completely regained his health, and upon his return to South Africa he took up the work of teaching, a task for which he was eminently suited. When Prof. Williams, of the Rhodes University, Grahamstown, left South Africa to take part in the War, Mr. Finlay took his place as professor of mathematics and surveying, and he remained there at work after Prof. Williams had returned, to within a few days of his death.

LÉON MAQUENNE.

LÉON MAQUENNE, whose death is announced, was born in 1853, and will be remembered as one of those able experimenters and clear-sighted research workers who made notable discoveries in the domain of organic chemistry when the science was still in its infancy and before any really definite views as to the structure of carbon compounds, especially those of natural origin, had been developed. His most noteworthy contributions deal with the structure of the sugar alcohols, important naturally occurring substances which, for many years, resisted the attack of the chemists of his time, and his first achievement in this field was the determination of the constitution of inositol, a compound which occurs widely in both the animal and vegetable kingdoms. He was able to show that this sugar alcohol was hexahydroxycyclohexane, and thus not only established the structure of the first member of an important new series, but also indicated the close relationship which exists between substances produced in the organism and benzene.

Maquenne was also successful in determining the constitution of perseitol, a seven carbon sugar alcohol which occurs in the leaves of *Laurus Persea*, but his most outstanding work in this connexion was probably the isolation of the dextro form of erythritol by the reduction of *l*-threose, a discovery which was shortly afterwards supplemented by the preparation of *d*-erythritol by his pupil Gabriel Bertrand, who isolated it by the action of the "sorbose bacterium" (bacterium xylinum) on natural erythritol. The two enantiomorphs were then united to form the *racemic* modification which was found to be identical with the compound which Griner had synthesised in 1893 from divinyl. The natural form of erythritol is the *meso* modification, but both the *meso* and *racemic* stereoisomers were prepared by Griner in his synthesis.

Of special importance also is the work carried out by Maquenne on starch, which is embodied in a series of papers published during 1904 and 1905. One outcome of this investigation was the discovery, made with Eugene Roux, that crude starch is a mixture of amylose and amylopectine.

During recent years Maquenne turned his attention more particularly to biochemical problems, and he was able to elaborate many important and delicate methods of analysis. His great range of knowledge led him, however, to carry out researches over a wide field, and to him, amongst other things, is due the preparation of pure acetylene from barium carbide, as well as the method of eliminating nitrogen from the air by means of metallic magnesium, which was ultimately used by Rayleigh and Ramsay in the preparation of argon.

ALL who are concerned in the world of shipping and in the electrical industry will learn with regret of the death on March 17, a few hours before his forty-sixth birthday, of Mr. W. W. Bradfield, general manager of the Marconi International Marine Communication Co., Ltd. Practical radio telegraphy, particularly in connexion with shipping, owes much to Mr. Bradfield, whose connexion with the Marconi Company dates from September 3, 1897, when he entered what was then known as the Wireless Telegraph and Signal Company, Ltd As electrical assistant to Senatore Marconi, in the earliest days of commercial wireless, Mr. Bradfield took part in experimental work on Salisbury Plain, and assisted in the erection of the wireless station at the Needles, Isle of Wight. In the year 1899 he installed the first wireless apparatus on British battleships, and a little later took charge of the demonstrations to the United States Government on board the U.S. battleship *Massachusetts*, while in 1901 he undertook similar demonstrations before the French Government, when communication was established between the French Riviera and Corsica. In the same year he supervised the erection of the famous stations at Siasconset (Nantucket Island) and the Nantucket Lightship. From 1902 until 1908 Mr. Bradfield was chief engineer to the Marconi Wireless Telegraph Company of America, and during this time he took part in the first International Radio-Telegraphic Conference, held in Berlin in 1906.

SIR WILLIAM PECK had occupied the post of City Astronomer of Edinburgh, in charge of the Calton Hill Observatory, since 1889, when the erection of the new Royal Observatory on Blackford Hill set the older building, with most of its instruments, at liberty He was of an active and inventive mind, and interested in all mechanical pursuits, besides astronomy. He constructed many of his own instruments. He was, in addition, a popular lecturer of considerable power and attraction, and was the author of a popular "Handbook and Atlas of Astronomy" and other works. The City Observatory was devoted chiefly to showing the heavens to visitors — a service much appreciated by the citizens. For this purpose a six-inch photovisual telescope, presented to the observatory, was of good service. In pursuance of the science, Sir William Peck visited Spain for the eclipse of 1905, and Egypt in 1908. He received the honour of knighthood in 1917. He died on March 7, after a long illness, aged sixty-three years.

WE regret to announce the following deaths:

Prof. A. Dendy, F.R.S., professor of zoology in the University of London (King's College), on March 24, aged fifty-nine.

Mr. H. E. Jones, president in 1917 of the Institution of Civil Engineers, on March 24, aged eighty-two.

Current Topics and Events.

IT has been common knowledge for some time in the scientific world that the Royal Society intended to dispose of part of the collection of early printed books in its library, especial attention having been directed to the fact in the report of Council issued to fellows in November last, and published in the Year Book of the Society. While it is true that during the last few years the Society has received large gifts of money, it has to be borne in mind that without exception the application of such moneys has been limited to certain definite objects, and none is available for the general purposes of the Society, however badly it may be needed, that, no doubt, explains the last sentence of the president's letter to the *Times* of March 27, "As circumstances stand, sentiment must be tempered by practical expediency." The larger portion of the books are relics of the collection presented to the Society in 1666 by Henry Howard, afterwards Duke of Norfolk, and only those volumes which have no scientific interest or are duplicates are being offered for sale, but two of the books which are likely to fetch very high prices—a Bible, and Richard Baxter's "A Call to the Unconverted," both translated into the Massachusetts Indian language—were presented to the Society in 1669 by John Winthrop, Governor of Connecticut. One of the features of the collection is a series of several hundred Reformation Tracts printed in Germany, more than one hundred of these being by Martin Luther. Among other books of interest are Caxton's second edition of "The Canterbury Tales," 1484, Fust's "Liber Sextus Decretalium" (1465), and Cicero's "De Officiis" (1466). A first edition of Euclid, included in the sale, is a duplicate. It is the intention of the president and Council that the proceeds shall be kept as a separate fund, known as "The Arundel Library Fund," to be used for the purchase of scientific books. A nucleus has already been formed by the sale to the British Museum, at its own valuation, of some seventy items.

THE Council of the Institution of Electrical Engineers has addressed a letter to the Postmaster-General stating that some of the provisions of the Wireless Signalling Bill are of such far-reaching importance that unless they are modified they will prove a serious hindrance to electrical and physical research. In particular the Council desires that it should be made perfectly clear that the words "any apparatus for wireless telegraphy" apply only to such apparatus when used for signalling purposes. Crystal detectors and radio valves, for example, are used in many physical laboratories for testing apparatus and materials which have no connexion with radio signalling. It should be clearly stated in the Bill that licences are not required in these cases. It is also recommended that all regulations made by the Postmaster-General under Clause 3 (Regulations and Fines) of the Bill should be submitted to a statutory advisory committee for consideration, and it is suggested that the committee should be representative of the Royal Society, the Institution of Electrical Engineers, the Radio and other interested societies. We think that this suggestion is a good one and would form an effective barrier against legislation which might injuriously affect research. It is also pointed out that Clause 7 of the Bill, which applies its provisions to the use of etheric waves for the transmission of energy, may greatly interfere with research and industrial development. A new clause might be substituted for it rendering liable to penalties any one using electromagnetic radiations of the frequencies commonly employed in radio telegraphy in such a way as to affect injuriously the working of authorised radio telegraphic stations. It is conceivable that in the future important industries may be founded on the transmission of energy by etheric radiations. Several suggestions for utilising these radiations have already been made, and it would not be in the national interest to hamper unnecessarily research in these directions.

THERE has been a considerable addition to our knowledge of scarlet fever during the last year through the researches of G. F. Dick and his wife, Gladys H. Dick, of the John McCormick Institute for Infectious Diseases in Chicago. Hitherto the causation of scarlet fever, like the other exanthemata, has been completely obscure. It was not regarded as likely that any of these fevers were due to ordinary bacteria, for although bacteria have been constantly found in one and all of them, no single bacterium isolated has been able to reproduce the disease in man or animals. The Dicks have, however, obtained (1923) a streptococcus from a case of purulent infection of the hand of a nurse suffering from scarlatina, and have directed attention to certain of its peculiarities. The application of pure cultures of this streptococcus has been alleged to produce scarlet fever in man, and it is concluded that, after all, scarlet fever is probably a bacterial disease analogous to diphtheria in its general pathogenesis. The organism is supposed to produce a local lesion in the throat, and a soluble poison produced in this site is absorbed into the system and is the cause of the rash and some other manifestations of the fever. By applying the toxin of the streptococcus scarlatinæ to the skin, a very definite red area appears in some persons but not in others. Where this "Dick reaction" is positive the individual is presumed to be susceptible to scarlet fever. Where the reaction is negative the individual is immune. These reactions are strictly analogous to the Schick reactions in diphtheria. It is possible to pick out the immunes from the non-immunes, and by inoculating the latter it is hoped that scarlet fever can be completely controlled as diphtheria has been. These results of the Dicks have been confirmed in all important respects by trustworthy workers in the United States, and the subject is now receiving close attention in Great Britain.

A STEP towards the improvement of loan facilities between libraries of university rank in Great Britain has been taken by the Association of University

Teachers, which recently convened a Conference to consider the matter. As a result, regulations for inter-library loans have been approved, and inquiries are now being dealt with by Mr. Oldaker, the University, Edmund Street, Birmingham, to whom all correspondence should be addressed. The movement is a healthy one, for it represents a reaction against the policy of library inflation which was characteristic of library administration in the latter half of last century. It is now seen that the future needs of the research student can only be met by a pooling of the resources of our research institutions. We have, however, some doubt as to the wisdom of instituting at this stage the inquiry office in Birmingham To provide prompt and accurate answers to inquiries as to the place of deposit of a given work presupposes the existence of an extensive collection of bibliographical serials and library catalogues which are to be found in few municipal or university centres. Moreover, the inquiry officer should have access to the work for the loan of which application is made. Further, the institution to which he is attached should be equipped with modern photographic copying apparatus Few institutions comply with these requirements The A U T. appears to have overlooked the fact that the bibliographical aspects of the problem should in the first instance have been left to the decision of bibliographers. We think it would be wise even at this stage for the A U T to refer its proposals to a small committee of experts to consider whether the institution of a separate inquiry office is best calculated to secure the professed objects, and in case of an unfavourable answer, to authorise the committee to submit alternative proposals.

SIR OLIVER LODGE's seventh and last "talk" of the series on "Ether and Reality," which is being broadcasted from the London station 2LO of the British Broadcasting Company, was given on March 31, and dealt with the probable utilisation of the ether. The ether or continuum has perfect properties, while matter is liable to deterioration and dissipates energy. No law of dissipation applies to the ether; matter exists not only inorganically but also as the complex molecules of protoplasm, which can be animated and made a vehicle for "life." But the coherence of all bodies is effected by the etheric connecting medium, and the question arises: Can that ether body be animated too? We usually ignore the ether body because it is outside the ken of our senses, but knowing what we know of matter and its fields of force, it is reasonable to suppose that we act more directly on ether than on the discontinuous particles of matter. All force is exerted through the ether, and it is thus that matter has become indirectly and apparently amenable to life and mind and memory and affection. These psychic attributes belong to the unseen universe; and if they require a physical medium, the ether is permanently available. Our material bodies have thus been built up, and are worked for temporary purposes of demonstration here and now, but they are imperfect and wear out. Mind may always need a vehicle, a body, a habitation, an instrument, but it need not be made of matter It is doubtful if matter is ever really animated directly. Our present connexion with matter is probably indirect as well as temporary Sir Oliver stated that, in his opinion, permanent reality lies in a region which does not appeal to the senses,—a region of inference, and to that region we really belong.

SIR ERNEST RUTHERFORD, in his discourse at the Royal Institution on Friday, March 27, on atomic nuclei, stated that the most direct method for determining the nature and magnitude of the forces that hold the atom in equilibrium, and the size and constitution of the nucleus, is to examine the scattering of swift α particles when they traverse matter Such experiments have shown that the inverse square law appears to hold over the greater part of the space occupied by the atomic structure. It breaks down, however, when the α particle approaches very close to a light nucleus like that of hydrogen or aluminium. By studying the variation of the number of α particles of different initial velocity scattered nearly backwards from the bombarded material, it has been found that there is a sudden change in the law of scattering for aluminium for a definite velocity Experiments made with thin films of gold and uranium show that the law of the inverse square holds to the closest distance of approach of the α particle to the nucleus, namely, about 3×10^{-12} cm. This is remarkable, for from radioactive information it is believed that the nuclear structure of uranium extends to more than twice this distance A distribution of charged electric doublets in the form of satellites extending some distance from the central nucleus may account for these effects. Previous work has shown that a change in nuclear structure can be brought about by intense collisions between α particles and light nuclei, but the fate of the α particle after liberating a proton has been a matter of great uncertainty Some recent experiments by Blackett show that in the case of nitrogen the α particle may be captured by the nucleus Thus in the case of nitrogen there is on the whole a building up rather than a disintegration. This result is of great importance and interest, but we are still far from understanding the mechanism of such disintegrating collisions.

A SERIES of interesting demonstrations has been given at Messrs Selfridge and Co., Ltd., London, W.1., by Mr. J. L. Baird, of an experimental apparatus of his own design for wireless "television" (*i.e.* the simultaneous reproduction at a distance of an image of a fixed or moving object) The inventor does not claim any great perfection for his results, but we have seen the production in the receiver of a recognisable, if rather blurred, image of simple forms, such as letters painted in white on a black card, held up before the transmitter. Mr Baird has overcome many practical difficulties, but we are afraid that there are many more to be surmounted before ideal television is accomplished. In the transmitting apparatus, the object, strongly illuminated, is placed opposite a revolving disc provided with a series of lenses, each a little nearer to the centre than the last, which project a

series of moving images upon a selenium or other photo-electric cell, each a little displaced laterally from the last. This is the equivalent of passing the cell over the whole surface of the object in a succession of close parallel lines. The light thus reaching the photo-electric cell is rhythmically interrupted by a rapidly revolving slotted disc, and the result is that owing to the variations of resistance of the cell, undulations at an audio-frequency are produced in the current through it, whenever a bright part of the object is being dealt with. These are amplified and supplied to a simple wireless transmitter which is caused to emit corresponding signals.

In the receiving section of Mr. Baird's television apparatus, the signals sent out from the transmitter are detected and amplified by very powerful valves until they are strong enough to light up a neon tube when a signal is received, *i.e.* when a bright part of the object is being dealt with by the transmitting apparatus. A disc with lenses or holes corresponding to the lenses of the transmitting disc is rotated synchronously with the transmitting disc, causing spots of light produced by the neon tube to appear upon a screen in positions corresponding to the part of the object being dealt with. With a sufficiently rapid rotation of the discs, a recognisable image of the object is produced. A duplicate of the receiving apparatus is provided at the sending end with its disc mounted on the same shaft as the transmitting disc, to enable the necessary adjustments to be made. Synchronism between the sending and receiving discs is obtained by a little alternator with a frequency of about 300 geared to the revolving system, which causes signals to be sent out by another wireless transmitter at this frequency. These are received and amplified at the receiving station to an extent enabling a similar little alternator connected to the receiving discs to be synchronised with them.

Dr. A. W. Crossley, presiding at the annual dinner of the Chemical Society on March 26, referred to the difficult position in which the Society finds itself on account of the increased cost of publication. Subscriptions of fellows have been raised, various limitations have been placed upon the distribution of the Society's publications, and papers are curtailed as much as possible, yet there is a financial deficit, and no practical means of avoiding it have yet been found. During the War, chemists saved the nation from disaster by supplying drugs, poison gases and protection from them, and other products demanded by the times, and it does not seem too much to ask that assistance should now be afforded in placing upon record the work they are doing for the advancement of knowledge. When one remembers the vast sums expended upon the verbatim reports of proceedings in Parliament published in the large volumes of Hansard, and considers how trivial most of the matters are in comparison with the original contributions made to a body like the Chemical Society, it is difficult to understand the national sense of value which leaves the Society in its present anxious position. Possibly the additional 1500*l.* received by the Royal Society in aid of scientific publication will enable a grant to be made to the Chemical Society, but in our opinion a very strong case can be made out by many other scientific societies for assistance towards costs of publication, either from the State or private benefactions, and we should like to see a concerted effort made with the view of securing adequate funds for this purpose.

Mr. W. J. U. Woolcock referred at the annual dinner of the Chemical Society on March 26 to a scheme for the establishment in London of a "Chemistry House" which would provide office accommodation for the chief chemical societies as well as one or more lecture theatres and other facilities. The scheme is being put on a business footing, and there is every reason to believe that it will take definite shape before long. It is possible that other scientific societies may like to be housed in the same building, and the plans may be enlarged to enable this to be done if there is a clear demand for such increased accommodation.

So far most of the clinical reports on "Bayer 205," now renamed "Germanin," have encouraged the belief that at last a specific for the treatment of trypanosomiasis has been found. A paper by Dr. Clement Chesterman in the Transactions of the Royal Society of Tropical Medicine and Hygiene (1924, vol. 18, p. 311) is somewhat disturbing from that point of view. Seventeen cases, all well advanced in the "second" or nervous stage of the disease, were treated with the new drug. Of these, nine had already received arsenical drugs without permanent improvement, and eight had not been given any previous treatment. Nine of these cases relapsed in from six weeks to fifteen months after a course of "Bayer 205." Two died of acute nephritis after their discharge from hospital and two from intercurrent bilharzial dysentery. Two more, who had suffered from amblyopia during arsenical treatment, became blind after administration of "Bayer 205," and a third developed amblyopia more quickly than usual when given arsenical treatment after a course of the new drug, due, it is suggested, to the possibility that damage to the kidneys by "Bayer 205" prevented the usual rapid elimination of the arsenic afterwards given. Two cases were definitely improved and have remained so for four and five months respectively. Unfortunately, none of the cases could be re-treated owing to the small supply of the drug available. It is pointed out that the two cases who died from acute nephritis might have been saved by careful nursing but were brought back to hospital too late. Dr. Chesterman has not lost faith completely in "Bayer 205," but thinks it important that "the limitations of yet one more of tropical medicine's 'conquering heroes' should be realised."

The genesis of "Bayer 205" is described in a recent paper (*Zeitschrift für angewandte Chemie*, 1924, vol. 37, p. 585) by Dr. B. Heymann, one of the chemists who took part in the long and arduous researches which resulted in its discovery. There

is a good deal of special pleading for the Bayer Co.'s refusal to disclose the constitution of the new drug, and this is critically commented on by M. Fourneau (who, it will be remembered, re-discovered "Bayer 205," or at least made an effective substitute for it) in *Chimie et Industrie*, 1925, vol. 13, p. 284. Whatever the ultimate value of "Bayer 205" as a remedy for sleeping sickness may prove to be, there can be no doubt that its advent has provided chemists and pharmacologists with new ideas for chemotherapeutical work.

PROF. H. A. LORENTZ, of Leyden, Holland, will deliver the fifteenth annual May lecture of the Institute of Metals on May 6 The subject of the lecture will be "The Motion of Electricity in Metals."

THE seventy-fifth anniversary of the foundation of the Royal Meteorological Society will be celebrated on April 21 and 22. The celebrations include a visit to Kew Observatory and a lecture by Prof. E van Everdingen, director of the Royal Netherlands Meteorological Institute, and president of the International Meteorological Committee

THE Fondation George Montefiore, given every three years for the best original work of the preceding three years on the scientific advance and on the technical applications of electricity, is to be awarded this year The 1923 award was deferred and the prize now amounts to 22,500 francs. The committee of award consists of ten electrical engineers, five of whom are Belgian, under the chairmanship of the Director of the Montefiore Electrical Institute of Liège. Competing works, addressed to M. le Secrétaire-archiviste de la Fondation George Montefiore, Association des Ingénieurs électriciens sortis de l'Institut électrotechnique Montefiore, rue Saint-Gilles, 31, Liège, must be received by April 30 next.

THE first annual report has been issued of the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Thirty-two applications for grants were received from various countries and eight awards were made, involving a sum of 8550 dollars. For the present, problems in or bearing on medicine are to be favoured and preference will be given to groups of researches on a single problem. Thus last year, four of the grants were for work bearing on chronic nephritis. Two only of last year's awards, to Dr. A. Bezredka, Pasteur Institute, Paris, and to Dr. J. Aberlin, Berne, went outside the United States. Applications for grants for 1925-26 must reach Dr. F. W. Peabody, Boston City Hospital, Boston, Mass., before May 15 next.

ARRANGEMENTS are in progress for a meeting of the Commission for the Exploration of the Upper Air to be held at the Meteorological Office, South Kensington, on April 16-22, under the presidency of Sir Napier Shaw. The Commission is in connexion with the International Meteorological Committee. The principal business of the coming meeting is to discuss the publication of the results obtained by balloons and kites in the various countries of the world during the years 1923 and 1924. A sum to meet the expenses of a specimen volume was allocated by the Union of Geodesy and Geophysics at Madrid in October last

AMONG the financial items recently adopted by the French Chamber of Deputies is one of unusual interest to scientific workers. The clause in question is due, according to the *Revue générale des Sciences*, to Prof. Emile Borel, and provides for a tax of 5 centimes on each 100 francs paid in salaries by French commerce and industry, and the products of the tax, which it is estimated will bring in about fourteen million francs a year, is to be allocated to French scientific laboratories. In this way it would seem that industry might be made to contribute directly to the support of the fundamental scientific research on which it is based The measure has still to be passed by the Senate before becoming law

THE Norwich Castle Museum Committee of the City Corporation has under consideration the celebration of the centenary of the foundation of the Museum under the presidency of the famous Norwich botanist, Sir James Edward Smith, F R S, in 1825 The history of the Museum shows that its fortunes were of a varying character until 1894, when the Corporation took over the collections of the Museum Society and housed them in the spacious galleries adjacent to the Castle. The year 1925 is important for the City of Norwich, as in addition to the celebration of the centenary of the Museum, there will be an official opening of the Bridewell Museum of Local Industries in the 13th-century house of the first Mayor of Norwich, which will provide about 11,000 feet of floor space for the exhibition of material illustrative of the textile and other past and present industries of the City of Norwich

IN publishing the first biological number of the Science Reports of the Tohoku Imperial University, Sendai, Japan, Prof. S. Hatai announces the formal opening of the Biological Institute of this University and of a Marine Biological Station, located at Asamushi. Among the special features of this station is an under-sea laboratory and a spacious open marine pool for observations on the growth of marine organisms Several residences and a large dormitory have been erected where investigators may live with their families and where students may find suitable accommodation. Prof. Hatai hopes that his colleagues in Japan and in other countries may take advantage of the facilities offered for research

YEAR-BOOK No. 23 of the Carnegie Institution of Washington, recently issued, contains a report by the Department of Genetics The investigations reported upon range from chromosome studies in Datura and Drosophila, sex conditions in Cladocera, pigeons, and moulds, to the genetics of rabbits, mice, and horses, and eugenic studies of Indian-negro-white racial complexes in Virginia, inheritance of exceptional intelligence, the endocrines of mongoloid idiots, and a European study of the ancestry of American immigrants No attempt can be made here even to outline the results obtained in these and other fields of research, but it is clear that substantial

progress is being made in such problems as the further analysis of the relations between chromosomes and heredity, and the compilation of data on which the improvement (germinally) of the human race could be based.

WE have received the annual report for 1924 of the Crichton Royal Institution, Dumfries—a hospital for mental diseases Both private and rate-aided patients are admitted, numbering approximately 630 and 339 respectively during the year. Some 70 per cent. of the private admissions were voluntary, but all the rate-aided admissions were under certificate, and the medical superintendent, Dr. Easterbrook, comments forcibly on the obsolescent provisions and objectionable terminology under existing statutes which officially distinguish the latter class as "pauper lunatics," and he points out that the absence of definite statutory provision for the treatment of rate-aided patients as voluntaries has had unfortunate results. A well-equipped clinical and pathological laboratory conducts much useful work at the Institution, which has received commendation from the Commissioners of the General Board of Control after inspection.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned Grade IV. of the Civilian Educational Staff of the Royal Air Force, preferably with engineering qualifications and experience.—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2, Bio-chemist at Dove Marine Laboratory, Cullercoats.—The Registrar, Armstrong College, Newcastle-upon-Tyne, an assistant lecturer in the department of physiology of the Welsh National School of Medicine.—The Secretary, University College, Cardiff (April 11); a lecturer in morbid anatomy and histology in the University of Manchester —The Internal Registrar (April 15), a research fellowship at Somerville College, Oxford, open to Oxford women graduates —Miss Lorimer, at the College (April 16); woman as principal administrative officer of King's College for Women, Household and Social Science Department, Campden Hill Road, W 8 —The Chairman of the Executive Committee (April 16), two assistant lectureships in physics in the University of Manchester —The Internal Registrar (April 18), the professorship of bio-chemistry at Middlesex Hospital Medical School —The Academic Registrar, University of London, South Kensington, S W 7 (April 23), the professorship of chemistry and directorship of the department of chemistry, the University of Birmingham —The Secretary (May 1); four scientific assistants for the science exhibition of the Royal Society at the British Empire Exhibition.—The Secretary, British Empire Exhibition Committee, Royal Society, Burlington House, W 1

Our Astronomical Column.

TWO NEW COMETS.—Comet 1925 *a* was discovered by Herr Schain at Sineis Observatory, Crimea, on March 23. It is of the tenth magnitude and visible in moderate telescopes When discovered it was near β Virginis, and was moving slowly to the north-west Being nearly opposite to the sun, it is observable for most of the night. The following positions have come to hand

G M T (new)	App R A.	App N. Decl.	Observer	Place
d. h m	h m s.	° ′ ″		
Mar. 23 22 43 6	11 47 48·9	1 43 49	Schorr	Bergedorf
,, 25. 23 42 3	11 44 8 3	1 53 46	Vinterhausen	Copenhagen
,, 27 23 37 5	11 40 32 2	2 3 22	Steavenson	Norwood
,, 29 0 22 0	11 38 39 7	2 7 53	,,	,,

The last place depends on an approximate position of the star $BD + 2°$ 2468, mag 9·5, assumed place for 1925·0, $11^h\ 39^m\ 6{\cdot}3^s$, 2° 12′ 12″ Use should not be made of this position until a better star-place is available The comet's R A is diminishing by about $1^m\ 53^s$ daily, its declination increasing by 5′ daily.

The orbit has not yet been calculated, but the ascending node is evidently near 0°, and the inclination not large, this fact would make an elliptical orbit not unexpected

Comet 1925 *b* was found by Mr William Reid at Cape Town on March 24 It should be stated, in correction of some paragraphs in the press, that Mr. Reid, whose diligence and success in comet-sweeping are well known, is not on the staff of the Cape Observatory, but is an amateur

This comet is brighter than the other, being of magnitude 8, but its low altitude is a hindrance to easy observation in England. The following positions have come to hand

G.M T (new)	App R.A	App. S Decl.	Observer.	Place.
d. h m	h m s.	° ′ ″		
Mar. 24. 21 33 0	13 29 47	20 16 0	Reid	Cape Town.
,, 28. 1 9 4	13 26 58 3	21 5 16	Steavenson	Norwood.
,, 28 2 49 0	13 26 54 5	21 6 13		Algiers
,, 29 1 12 0	13 26 0 1	21 20 36	Steavenson	Norwood.
,, 29 1 29·0	13 25 59·8	21 20 54	,,	,,

The R A is diminishing by 54 sec daily, the south declination increasing by nearly 16′ daily

The orbit has not yet been calculated, but, as in the case of Comet 1925 *a*, the observations given should be sufficient to deduce preliminary orbits. Reid's comet is not far from γ Hydræ, and is due south about three-quarters of an hour after midnight. There will be more chance of observing the comets after the moon has set.

BROADENING STELLAR SPECTRA.—In Mon Not. R A.S, vol. 85, p 47, Dr W. J. S Lockyer, Director of the Norman Lockyer Observatory at Sidmouth, describes a new method of broadening stellar spectra for purposes of reproduction. Since stellar images are merely points, the spectra have no breadth unless special methods are adopted to broaden them. For practical purposes it is customary to allow the image of the star to "trail" on the photographic plate by a suitable adjustment of the rate of the driving clock, but very little breadth is usually possible owing to the increased time of exposure entailed. Further, various unavoidable irregularities in brightness make the spectra broadened in this way unsuitable for picturesque reproduction. In the arrangement devised by Dr. Lockyer, the original negative, showing a narrow spectrum (after being specially prepared in a manner explained in the paper) is allowed to fall under gravity in a direction parallel to the spectrum lines, its speed being regulated by a flow of oil which, by an ingenious arrangement, is produced by the fall. During the fall the negative is illuminated by a constant source of light and photographed, the breadth of the spectrum thus obtained clearly being determined by the distance of descent. The paper contains an account of investigations made to determine the most satisfactory time of exposure, and also a beautiful photograph of the spectrum of *a* Cygni broadened by the new method.

Research Items.

THE STONE AGE IN THE EASTERN SAHARA.—In the course of an account of the oasis of Kawar (Kaouar), Eastern Sahara, in *La Nature* for March 14, Capt. Marius Prevost, who writes in collaboration with Dr. Lucien Mayet, describes stone implements found on a considerable number of sites in the oasis explored by him. The implements occur in such numbers as to suggest that the oasis supported a considerable population from an early date In addition to flint, which was imported, quartz, quartzites, silicious limestone, hæmatite and volcanic rocks were used in the manufacture of the implements In the absence of stratification, the only indication of date is the somewhat uncertain evidence of type On this basis certain implements worked sometimes on one side, sometimes on both; flakes, points, carinated implements, etc , would, if found in Europe, be classified beyond question as palæolithic, while others, arrowheads, with or without tang, or triangular, spear-headed knives, polished axes, etc , would belong to the neolithic. Beads and pendants of stone and ostrich shell were also found. The neolithic industry shows strong affinities with that of Egypt which, if contemporary, would indicate an antiquity of 9000 to 12,000 years, and the palæolithic type might therefore be assumed to be older still. Up to the present, neolithic typology in the Sahara seems to point to a great uniformity of culture in the whole area.

ARCHÆOLOGICAL RESEARCH IN CENTRAL AMERICA IN 1924.—A report by Dr. Sylvanus G. Morley, in Year Book No. 23 of the Carnegie Institution of Washington, covers a number of investigations in Central America. A fourth Initial Series from the Maya New Empire region of Yucatan has been discovered. Excavations by Mr. E. H Morris at Chichen Itza in the "Court of the Thousand Columns" have cleared the North-eastern Colonnade, an edifice 100 feet in length by 49 feet in width facing south. On three sides and part of the fourth it was bounded by solid walls, but the remainder of the support of the superstructure was a series of 5 rows of columns, rectangular in cross section. Their height was 8 feet. The season's excavations confirmed the type of the most prevalent form of column-supported structure at Chichen Itza, with a rectangular plan, arches paralleling the longer dimension, and an altar or throne at the centre in the rear. In the course of a survey of the archæological area by Mr. Kilmartin, a number of partly finished sculptures were discovered which throw light on the technical practices of the Maya in this art. Measurements of the great terrace show that it contained an area of 47 acres and, in some places, was built up to a height of 25 feet. At Uaxactun, Guatemala, a structure was discovered which appears to have been a sun observatory. Dates on three stelæ discovered nearby equate with A.D. 97 and A.D. 235, and the observatory, therefore, if it be one, cannot have been erected later than the latter year and was planned before the two earlier stelæ were set up. Excavations by Mr. O. G. Ricketson, jun., in mounds at Baking Pot, British Honduras, have brought to light a number of skeletal remains. In a sepulchral structure were found seven skeletons. In two the upper front teeth were filed, and in one the five upper teeth were inlaid with circular fillings of iron pyrites. All showed signs of fronto-occipital flattening.

FISH TRAPS IN EASTERN ASIA.—The distribution of thorn-lined traps in Assam and farther east is discussed by Mr. Henry Balfour in *Man* for March. The principal feature of these traps is that the inside of a conical trap is lined with the thorns which beset the leaf-ribs of climbing palms (Calamus, Dæmonorops, etc.), the sharp points being set toward the apex of the cone, thus rendering exit impossible when the trap has once been entered. Such traps had not been recorded from the Naga Hills of Eastern Assam prior to 1922, although their existence seemed probable from the Indonesian affinities of Naga culture Inquiry, at first unsuccessful, finally produced an example from the Lhota Nagas from Okotso Village which is practically identical with the forms which range through the Malayan and Indonesian areas and extend as far as Melanesia. Several varieties of similar traps have since been collected from other Naga tribes by Mr J P Mills. Varieties of the trap are noted from Western Burma, Malaya, Sumatra, the Philippines, Borneo, New Guinea, where it is widely distributed, New Britain, and the Solomon Islands. Though the place of origin is uncertain, there is no doubt that these thorn traps are referable to a common prototype and form a connected series.

THE DISCOVERY OF THE ANTARCTIC CONTINENT.—It has long been the practice to credit Sir J. C. Ross with the discovery of the Antarctic continent when he sighted South Victoria Land in 1841 Some years ago the late Dr. W S. Bruce showed that the real discovery was made in 1820, when E. Bransfield sighted Trinity Land, a part of that section of Antarctica now known as Graham Land. In the *Geographical Journal* for March, Lieut.-Commdr R T. Gould publishes the full evidence on which Dr. Bruce based his contention. Bransfield's own log-book has disappeared, but contemporary accounts of his voyage are available. One of these that had previously been overlooked, together with Bransfield's own charts, which are in the possession of the Admiralty, make it clear that in January 1820 he sighted the northern extremity of the mainland in the vicinity of the mountain which now bears his name. Lieut.-Commdr. Gould's article is accompanied by a chart on which Bransfield's discoveries are shown in relation to more modern surveys, and his track is marked as accurately as is possible in the absence of the log of the *Williams*

USE OF STIBAMINE IN KALA AZAR.—In the *Indian Medical Gazette* for January 25, Dr. Napier, who is in charge of kala-azar investigations at the Calcutta School of Tropical Medicine, has an interesting note on the treatment of this disease by derivatives of stibamine (*p*-aminophenylstibinic acid). It is well known that sodium antimonyl tartrate is an effective remedy, but it is slow and the coolie victims prefer as a rule to put up with the disease rather than submit to injections of this drug for several months. Improved remedies are therefore urgently required, and chemotherapeutical and clinical experiments carried on in Germany, England, and India during the last ten years have shown that stibamine is almost certainly as specific in its action in kala-azar as any drug can be. Unfortunately it is unstable and too toxic for use, and the difficulty has been to find a stable form in which to administer it. The acetyl derivative, which at first seemed promising, had to be abandoned after several accidents with it, but three other promising compounds are now under trial; urea-stibamine, which appears to be a combination of carbamide and stibamine of unknown constitution, discovered by Dr. Brahmachari of Calcutta; *meta*chlorostibacetin, produced by von Heyden

of Dresden, and stibamine glucoside, first made a few months ago in the Wellcome Chemical Research Laboratories, which is the subject of the note by Dr Napier referred to above All three new drugs seem to be about equally valuable as curative agents, and the period of treatment by them is reduced to two or three weeks. It is too soon to say which of them will prove most effective, but their advent marks an important step in the treatment of another tropical disease.

THE ŒSTROUS CYCLE IN CATTLE.—H. S Murphey has published a paper on the œstrous cycle in the cow, in the Journal of the American Veterinary Medical Association (vol 65, August 1924), and G W McNutt in the same number has given an account of the corpus luteum in the cow in relation to the cycle. The cycle is divided by the former author into two main periods, diœstrum and œstrum, and the latter is subdivided into proœstrum, œstrum in the restricted sense (*i e* the actual time when coitus may occur), and postœstrum Both the vagina and the uterus are shown to undergo marked cyclical changes, pronounced congestion and œdema beginning with the proœstrum and not subsiding until four or five days later. In the case of the vagina the congestion and œdema are followed by active secretion McNutt describes ovulation as occurring shortly after "heat," an observation which agrees with what has been found by John Hammond, whose investigations at Cambridge have covered much the same ground, but have not so far been published The corpus luteum is said to be formed both from the follicular epithelium and from the theca interna. It may commence involutionary changes after 14 to 16 days, but there is some individual variation. In young animals the involution is completed in a year or somewhat less, but as the cow grows older, involution takes place more slowly and is less complete. The colour of the corpus luteum is at first a light brown, about the 7th day an old gold, by the 14th day a bright golden yellow, and by the 20th an orange colour, eventually changing to a bright brick red The colour change is associated with the quantity and character of the lipoid in the luteal cells.

FRUIT TEMPERATURES IN CALIFORNIA.—A discussion of considerable value to fruit-growers is given in the recently issued *Monthly Weather Review* for August 1924 in an article on "Substitution of fruit temperatures for air temperatures in regulating orchard-heating for oranges" The essential features of the discussion aim at improvement in eliciting a more precise estimate of the lowest temperature to which fruit can be subjected without damage For thirty years or more, orchard-heating has been practised in the United States, mostly without exact data as to effective damage, and based on the reading of sheltered and unsheltered thermometers in varying degrees of proximity to the fruit. The frosts are found not only to render the fruit unmarketable, but also in many cases to prevent the crop being included in the "choice" or "extra choice" grades. Information is given to show how successfully under ordinary cold the fruit escapes damage. A special mercurial thermometer is used; the bulb of the instrument is inserted well into the fruit, and readings from this are used for determining when the heaters should be lighted, the thermometer is somewhat similar to a clinical thermometer It is asserted that from 85 to 90 per cent. of the fruit is screened from the sky by foliage. The freezing-point of the juices of the fruit varied from 26° to 28·5° F., and examples are given of the temperature falling to about 24° F. before the juice began to freeze. The amount of damage to mature fruit depends largely on the thickness of the rind.

LEECHES FROM KASHMIR.—Dr. J. Percy Moore describes (Proc. Acad. Natural Sci., Philadelphia, vol 76, pp 343-388, 1924) the first collection of leeches from Kashmir, and it is interesting to note that the following species are included—*Glossiphonia complanata*, *G weberi*, *Hemiclepsis marginata* (subsp. *asiatica* nov.), *Erpobdella octoculata*, and *Dina weberi*. The first, third, and fourth of these are widely distributed and abundant Eurasiatic species, the first being even holarctic The remaining two are characteristic Indo-Malayan forms. Dr. Moore also gives an account of a collection of leeches from eastern China.

CRITICAL STUDY OF LEIDY'S ACANTHOCEPHALA.—Dr H J. Van Cleave has investigated the specimens of Acanthocephala in the Leidy collection deposited in the University of Pennsylvania and in the Academy of Natural Sciences, Philadelphia, and gives a critical review of this important material (Proc Acad. Natural Sci., Philadelphia, vol. 76, pp. 279-334, 1924). He states that of the North American genera of Acanthocephala known at the present time fully half had come to the attention of Leidy. The author gives in tabular form a list of the specific names used by Leidy and the valid or corrected names, pointing out at the same time that Leidy's work was characterised by great care and that some of his difficulties in identification were due to the incomplete description of European species. Twenty-one species are represented in the collection and they are arranged under thirteen genera.

EXPERIMENTAL STUDIES ON *DIBOTHRIOCEPHALUS LATUS* IN MAN.—G. Z. L le Bas (*Journ. Helminthology*, vol. 2, No. 4, 1924) publishes observations on three persons who infected themselves with this tapeworm by swallowing the plerocercoid stage obtained from pike taken from the Lake of Neuchâtel. Case A was infected with three worms which attained maturity (as evidenced by finding the eggs in the fæces) in 20 days; case B was also infected with three worms which reached maturity in 14 days, while the single worm in case C took 26 days to reach sexual maturity. The average length of the three worms from case B after 99 days was 22 feet, and the number of eggs present about this time per gram of dried fæces was about 7 millions in case A, and in case B 12¼ millions about the 90th day of infection and 17½ millions on the 99th day. Intestinal disturbance is associated with the period of maturation of the worm, but, apart from this diarrhœa in the early stages, infection with three Dibothriocephalus for so long as nine months does not necessarily give rise to any symptoms which would suggest the presence of the parasite. No appreciable anæmia was produced, nor was there a definite diminution of the red blood corpuscles. Leucocytosis and an increase of the polymorphonuclear cells was observable in a slight degree, especially early in the infection.

CLASSIFICATION OF IGNEOUS ROCKS.—E. T. Hodge proposes a new form of classification for igneous rocks in a Publication (vol 2, No 7, 1924) of the University of Oregon. The older classifications are ably summarised and criticised. Single plane arrangements have hitherto been far from satisfactory. Winchell employed three planes exhibiting relative degrees of "alkalinity"; Holmes used five planes, dividing rocks according to Shand's saturation principle; and Johannsen used a solid double tetrahedron, thus introducing obvious difficulties in presentation. It is claimed that the new method

avoids the defects of previous attempts. The first division is into four *classes* based on the percentage of felspars plus felspathoids. Each of these is divided into seven *ranges* according to the principle of saturation Further subdivision is into nineteen *orders* depending on the ratio of orthoclase to the various types of plagioclase. The division thus makes provision for a large number of different types of rocks, all of which can be represented quantitatively in a plane circle on a single sheet. Four segments of the circle take the classes Six smaller concentric circles give seven spaces for the ranges, and each segment is divided into nineteen smaller segments by radial lines to take the orders. So far only mineral composition has been considered, though the author makes the remarkable claim that, whether chemical or mineral composition be given, the rock will fall into the same division of the classification. Texture next requires attention, and to meet the formidable difficulties inherent in any cross classification of so variable a factor, it is suggested as a simple expedient that to each a symbol be given which could be added to the rock name as a subscript. As a mental prop a classification of this kind may have its use, but petrology has now passed the stage in which it would have been considered as a contribution to the development of the subject.

UNITED STATES COASTAL SURVEYS.—The Report of the United States Coast and Geodetic Survey for the year 1923–24, published by the Department of Commerce, Washington, contains a long record of useful work and a review of the present state of the various hydrographic, geodetic, and magnetic surveys now in hand. Among the surveys of the year the progress in Alaska was very notable. So far the work has been mainly in the waters of southern Alaska, but it is spreading northwards to the shores of Bering Strait. A new survey of the waters of the Philippines is nearly complete, and a survey of the Virgin Island waters is half finished. The provision of several new survey vessels has greatly facilitated the work of the department. The results of experiments with the sonic depth-finder on the *Guide* are promised in a separate report. The apparatus is to be used in extending the survey of Pacific coastal waters to the 1000-fathom line The Report is furnished with numerous maps showing the present state of surveys.

FLOTATION METHOD OF CLEANING COAL.—In the Bulletin de la Société d'Encouragement pour l'Industrie Nationale of January recently received, Charles Berthelot describes fully the process of cleaning fine coal by the flotation method, and points out the advantages to be derived therefrom. He gives an account of the plant employed at the Fiscal Mines of the Netherlands, devised by the chief engineer, Mr Kleinbentink, which differs from the well-known plant of the Minerals Separation Company in that the frothing chamber is circular in plan surrounded by a circular chamber for collecting the froth. In Holland it has given very satisfactory results, and the working costs are only half of those incurred by the Minerals Separation Company, namely 1·32 francs as against 2·66 francs per ton. The mines in question are dealing with 100,000 tons per annum of coal slimes, the ash content of which is reduced from 30 per cent. to 8 per cent., the floated coal being well adapted to the preparation of either metallurgical or foundry coke or briquettes. It is stated that the cost of a plant to treat 50,000 tons of coal slimes per annum amounts to 200,000 francs and can make a gross profit of 850,000 francs per annum. The article makes no reference to the means employed for removing the water from the froth in the Dutch plant described.

DIAMOND HARDNESS TESTING MACHINE.—In the Brinell hardness test, the steel balls hitherto used for making measurable impressions under load were themselves deformed when indenting very hard specimens. The results fell off in accuracy at an early stage Messrs Vickers, Ltd., have now produced a machine, employing a small diamond pyramid (included angle 136°) as indenter, which gives trustworthy readings upon the very hardest steels. The use of a pyramid is scientifically sound, and the "hardness numbers" are similar to, if not identical with, those of the universally adopted Brinell scale. The indentations are very small, and the machine meets almost all the demands of a modern metallurgical hardness tester, for (*a*) the load is applied at a constant rate and for a constant time; (*b*) the load may be varied from 10 to 100 kgm to suit the sample being tested; (*c*) thin sections, *e.g.* hardened safety razor blades, may be tested; and (*d*) there is no damage to finished work. The machine is suitable for research and general use, as loading is automatic and the measuring operations are simplified A microscope is swung into position directly over the specimen, and knife edges in the eyepiece are brought up to opposite corners of the indentation The reading then appears externally in actual figures

SOLUBILITY AT HIGH PRESSURES.—A method of determining solubility at high pressures, by means of measurements of electrical conductivity, is described by Messrs. E. Cohen and J. C van der Bosch in the *Zeitschrift fur physikalische Chemie* of January 20 Thallous sulphate was employed, as the alteration of volume on solution is large, and a considerable alteration of solubility with pressure was to be expected. Measurements were made at various concentrations to find the relation between concentration and resistance at high pressures. To determine the maximum solubility, at 1500 atmos. for example, weighed quantities of thallous sulphate and water were taken, which would give a slightly oversaturated solution at 30° C; this was placed in a suitable resistance vessel in a compression bomb, which could be constantly shaken by means of a mechanical arrangement driven by an electric motor. The pressure was raised to 1800 atmos., and the salt dissolved completely, when the pressure was reduced to 1500 atmos., without shaking, a supersaturated solution was obtained the resistance of which was determined After long shaking the excess of salt gradually crystallised out, the resistance rising and finally becoming constant. From these measurements it was possible to find the amount of salt in the saturated solution. The method takes a long time, but the results obtained agree well with those arrived at by other observers, using the direct method.

ZINC OXIDE INDUSTRY.—An account of the zinc oxide industry by Dr. N. F Budgen appears in the *Chemical Trade Journal* for February 20. Zinc oxide has been known from the times of antiquity; the ancients called it *tutia*, and the alchemists referred to it as *nix alba*, "philosophical wool," or flowers of zinc Courtois recommended its use as a paint in 1770, and in 1781 he commenced the large-scale manufacture of the substance. The Wetherill process in the United States involves the reduction and distillation of zinc from oxidised ores mixed with a certain amount of anthracite to act as reducing agent. The vaporised zinc is quickly oxidised, and with the gases of combustion is drawn from the furnaces and cooled in a system of flues and chambers, finally passing into a series of muslin bags which act as filters, allowing the gases of combustion to escape, at the same time retaining the condensed zinc oxide. The difficulties and drawbacks in the Wetherill process are discussed.

The Molecular Mechanism of Capillary Phenomena.[1]

By N. K. ADAM

AN important question for the theory of capillarity is this: Is it necessary, in order to explain the observed phenomena, to conclude that there is, in the surface of a liquid, any differentiation of the molecular arrangements and forces from those prevailing in the interior, of such a nature that there is a skin possessing a tension parallel to the surface? Many writers appear to assume that, because the free energy associated with each unit of area of the surface is most conveniently replaced in calculations by a tension parallel to the surface, there must be some special structure in the surface which produces this tension physically. Although any free energy resident at the surface may mathematically be considered as the product of a "surface tension" and the area, there is no justification in this fact for concluding that the molecular arrangements and forces at the surface resemble those in a stretched membrane. Indeed, probably all attempts made to explain the molecular structure of surfaces, which have assumed such a contractile mechanism, have been complete failures.

Recent work on films of fatty material, one molecule thick, on water surfaces, has been satisfactorily interpreted in terms of molecular structure by regarding the molecules of the film simply as small floating objects, which attract one another when close enough, and repel when quite closely packed; thus assuming only the ordinary properties of molecules. If a film of this nature is confined by barriers to a given region of the surface, the force on the barriers is regarded as a compression on the floating film. Very striking analogies between the structure of the films, and the structure of matter in three dimensions and in solid, liquid, and gaseous states, have been revealed on this assumption; while if the force on the barriers had been treated as the difference between two tensions, those of the clean and contaminated water surfaces, no progress could have been made in unravelling the molecular structure. The two ways of regarding the films are mutually exclusive, and the success of the "compression theory" casts much doubt on the reality of any structure in the surface which produces tension.

A liquid probably has a well-defined surface, a surface of water forms a satisfactory support for films one molecule thick, which are as closely packed as matter in solid or liquid form, and will withstand lateral compression of one or two hundred atmospheres, calculated on their thickness. Only a liquid of density practically the same at the surface as in the interior could form a stable support for such films. The rarefied transition layers between liquid and gas, discussed by Van der Waals, can scarcely be conceived as able to bear these condensed films.

The surface energy of all liquids, and the tendency to diminish the surface to a minimum, are due in the following way to the molecular cohesion. In the interior, a molecule is attracted equally in all directions by its neighbours, at the surface the attraction outwards is lacking, and every surface molecule is therefore attracted inwards. Simple cohesive forces will produce no other net force on the surface molecules. This is sufficient to cause molecules to leave the surface more frequently than they reach it, and consequently, since the molecules occupy a definite area in the surface, the surface diminishes. The free energy of the surface is the work which must be done to bring the number of molecules requisite to form unit area, to the surface, against this inward force.

There are two other arguments sometimes cited as evidence of the existence of a surface skin; the floating of a heavy solid object on the surface of a liquid, and the spreading of one liquid on another. But consideration of possible molecular structures for the skins which would cause a liquid surface to diminish, and would resist perforation by a solid body, show that opposite qualities would be required in the two cases. The skin tending to contract the surface would essentially expel molecules from itself; but the skin which would act as a support for a heavy body would need such cohesion that it would be most unlikely, left to itself, to diminish indefinitely.

An experiment of Osborne Reynolds[2] renders it very probable that spreading of oil on water is due to an outward thrust from the oil drop, instead of a pull from the water surface. Oil placed on a dusted surface of clean water pushes the dust back as it advances, only immediately at the edge of the advancing oil, there being obviously no contractile motion over the rest of the water surface. A force which can produce this expansion in the form of a thrust from the drop is not far to seek. The molecules of the water are in constant thermal agitation, and the horizontal components of this motion act in the required direction, and will carry out the molecules of oil along the surface, if they are sufficiently adherent to the water molecules to share in their motion, and are not more attracted by the oil than by the water. Evidence of the importance of these thermal motions parallel to the surface is also given by the behaviour of the monomolecular films, as the temperature rises. It is found that, when the temperature is high enough, the disruptive effect of the agitation overcomes the lateral attraction between the film molecules and causes expansion to take place, the expanded film being analogous to a two-dimensional gas.

These thermal agitations also account for the diminution of the free surface energy, or "surface tension," of all liquids with temperature. If the surface is warmer on one side of a floating object than on the other, the intensity of the horizontal bombardment on this object is greater on the warm side than on the cold. We need not regard the observed motion towards the cold side as due to the attraction of the surface skin being less on the warm than on the cold side. By reason of this difference in intensity of bombardment, work must be done to increase the area of the cold surface at the expense of that of the warm, and the "surface tension" of the cold surface is greater than that of the warm.

It is well known that the pressure is greater on the concave side of a curved liquid surface than on the convex, and that the amount of this excess pressure is $\eta\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$ where η is the "surface tension" and R_1 and R_2 the principal radii of curvature of the surface. The amount of this excess pressure can be deduced simply from the fact of a free energy η per unit area of the surface, by considering a variation of the area of surface, keeping the volume constant. The fact that its magnitude is the same as if the surface were covered by a membrane of tension η is not evidence as to the molecular mechanism by which the pressure is produced.

At the free surface, the attractions perpendicularly

[1] Based on a lecture delivered to the Physical Society of Sheffield, on October 28, 1924.

[2] Works, vol. 1, p. 410. Brit. Ass. Rep., 1881.

inwards on the surface molecules produce a pressure on the underlying molecules, the "internal pressure." Fig. 1 will show that on a plane surface the forces producing this pressure are parallel; on the surface convex outwards they are convergent and therefore the pressure is greater; on the surface concave outwards they are divergent, giving a smaller pressure than under the plane surface. Thus the unbalanced perpendicular attraction on the surface accounts for

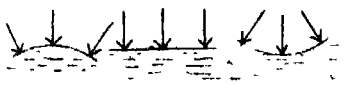


FIG. 1.

the pressure under a curved surface, without the assumption of an elastic skin

Where the surface is the surface of separation between two liquids, or between a solid and a liquid, the attractions on the surface molecules of each phase towards the interior of that phase are modified and usually less than at a free surface; but the only net force on the surface molecules is an attraction away from the boundary. The equilibrium between the forces of attraction at the interfaces of solid, liquid, and gas, in contact, results in the angle of contact (Fig. 2). If W be the work per unit area required to

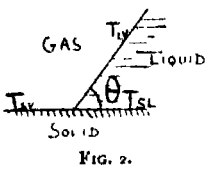


FIG. 2.

separate the solid from the liquid perpendicularly, then

$$W = T_{SV} + T_{LV} - T_{SL} \quad . \quad . \quad (1).$$ [8]

W may be called the adhesion of the liquid for the solid. Further, the equation

$$T_{SV} = T_{SL} + T_{LV} \cos\theta \quad . \quad . \quad . \quad (2)$$

may be obtained by taking account of the changes of area involved in a virtual displacement of the line of contact of solid, liquid, and gas. Hence

$$W = T_{LV}(1 + \cos\theta). \quad . \quad . \quad . \quad (3).$$

By (3), a zero angle of contact indicates that the adhesion of the liquid for the solid is equal to the cohesion ($2T_{LV}$) of the liquid for itself; 90° shows the adhesion to be half the liquid cohesion, and 180° would indicate no adhesion.

When there is motion of the liquid over the solid surface, the angle of contact is different. If the liquid is advancing, the angle is greater, if receding, it is less, than the equilibrium value. The amount of this difference, sometimes called the hysteresis of the angle of contact, probably depends more on the smoothness of the surface than on its chemical characteristics. For a rough surface of paraffin wax, for which the equilibrium angle is 104° 30′, the difference between advancing and receding angles may amount to nearly 60°; and on such a surface it is practically impossible to obtain the equilibrium angle, within several degrees. However, on a wax surface which had been turned in a lathe, Ablett [4] obtained consistent results, within a few minutes of arc, for the equilibrium angle. Mr. G. Jessop has pointed out that this "hysteresis" is probably due to the friction of the liquid on the solid surface, acting to oppose the motion. If the frictional force is F, then for advancing motion, equation (2) becomes

$$T_{SV} - T_{SL} = T_{LV} \cos\theta_A + F,$$

and for receding motion,

$$T_{SV} - T_{SL} = T_{LV} \cos\theta_R - F;$$

hence the angle must be greater for advancing than for receding motion. Also,

$$2(T_{SV} - T_{SL}) = 2T_{LV} \cos\theta = T_{LV}(\cos\theta_A + \cos\theta_R),$$

therefore

$$2\cos\theta = \cos\theta_A + \cos\theta_R,$$

an equation approximately verified by Ablett, for his surface of paraffin wax.

This surface friction probably explains the third of the phenomena sometimes attributed to the surface skin, the floating of a solid object on a liquid of less density. In Fig 3, the line of contact between the liquid and solid surfaces will not move unless the part of the weight of the solid not supported by the

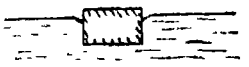


FIG. 3.

buoyancy of the liquid exceeds the frictional force F. In this way a substance heavier than water can float on the surface, as any depression of the line of contact below the level of the surface requires an increase in area of the liquid surface, if the angle of contact is greater than 90°, and requires the performance of work.

The sequence of events in the rise of a liquid in a capillary tube suddenly brought into the liquid will be, first, the setting up of an angle of contact (acute for a rising liquid), second, a diminution of pressure under those regions of the surface where there is disturbance due to the angle of contact, third, motion of the liquid upwards, by reason of this diminution of pressure, first probably to complete the meniscus, and then as a whole up the tube If the tube is dry, the liquid is advancing and the angle of contact will be greater than the equilibrium angle, the radius of curvature of the meniscus will be greater, the pressure deficiency under the curved surface will be less, than the equilibrium, and the liquid will not reach the equilibrium height in the tube, this is a well-known experimental fact. Washburn [5] has shown that the rate of movement of liquid in a capillary tube is in accordance with the value of the capillary pressure, and the viscous resistance to flow, but this does not serve to distinguish between this explanation and one based on the idea of "surface tension," since the capillary pressure is numerically equal to what would be caused by a membrane in tension. Rideal [6] obtains the same differential equation for the motion of the liquid, considering the force driving the liquid as a tension of magnitude $2\pi r\eta$, where r is the radius of the tube, and the liquid wets the walls perfectly.

In general, where the phenomena considered are merely consequences of the fact of potential energy in the surface, the term "surface tension" can legitimately be employed; but where the molecular mechanisms producing the phenomena are under consideration, the term is apt to be misleading, as it suggests some kind of contractile skin in the surface, the existence of which is very unlikely.

[8] Dupré's well-known equation. Equation 3 has been obtained by Edser, and a similar equation is obtainable from Laplace's theory, considering the attractions between particles of liquid and solid, and liquid and liquid.

[4] *Phil. Mag.* 46, p. 244 (1923).

[5] *Phys. Review*, 13, p. 273 (1921).

[6] *Phil. Mag.* 44, p. 1152 (1922).

The Syrian Arc.

THE Syrian Arc is the name proposed by Dr. E. Krenkel for a mountain chain which can be traced around the south and east of the Levant from Tunis to the Taurus The name is given in a short but important paper ("Der Syrische Bogen," *Centralblatt für Mineralogie*, 1924, No. 9, pp 274-281, and No. 10, pp 301-313) which correlates the mountain movements which have determined the position of the south-eastern Mediterranean. According to Dr. Krenkel, this mountain chain begins to the west in Tunisia, where there are two sets of fold mountains The predominant set belong to the Atlas System and its members trend to the north-east. The set in southern Tunis trends east and west and is obviously a distinct mountain group from the Atlas.

According to Dr Krenkel, this southern set is the westernmost element of the Syrian Arc It is cut off by the Great Syrtis from Cyrenaica. Dr Krenkel, from the writer's work on the geology of Cyrenaica, interprets its plateau as one of the inner members of the Syrian Arc In Egypt this arc is represented by three fold ranges, those of Abu Roasch, Wadi Araba and Quena. It continues with a trend to the east-north-east, across the deserts of northern Sinai, where it has been determined by Messrs. Moon and Sadek The Egyptian and Sinaitic members of the Syrian Arc are separated by the Gulf of Suez

According to one view, the Clysmian valley of Dr. Hume, which includes that gulf, is the direct continuation of the Rift Valley of the Red Sea According to another view, it is a synclinal. According to Dr Hume, it is due to a combination of faulting and a series of Erythrean folds. Dr Krenkel supports the first of these interpretations as the Gulf of Suez lies in a rift valley which has broken across the Syrian Arc nearly at right angles, and the structures which have been interpreted as due to a series of Erythrean folds Dr. Krenkel explains as due "to the tossing and tilting of unclinal sedimentary blocks which appear on the floor of the rift valley" He denies the existence of Erythrean folds due to pressure in a westerly or easterly direction.

From Sinai the Syrian Arc passes north; it is bounded westward by a series of steps down to the Mediterranean and eastward, according to some accounts, by flexures. Dr. Krenkel represents these flexures as fractures which have broken across pre-existing folds. He attributes the topography of this area to a combination of an older folding with the younger rift valley fractures In Syria, however, where the structure has been represented by Diener and most of his successors as determined by simple block structures, Dr. Krenkel insists on the importance of folds In middle Syria, the Lebanon on the west is separated by the great valley of the Bakaa from Mt. Hermon and the Anti-lebanon. This valley he attributes to a down-fold lasting from the end of the Cretaceous to the Upper Miocene; but the Bakaa in its present form he describes as a rift valley made by Pliocene fractures. The Damascus Arc is a branch from the Syrian Arc and is marked by the presence of the only overfolding recognised by Dr. Krenkel anywhere along the Syrian Arc, it happened there to a slight extent owing to the pressure of the Damascus Arc against the northern edge of the Arabian Foreland Farther north the Syrian Arc ends against the cross folds of the Taurus The line of separation is defined by Dr Krenkel as the Afrin line which divides the African element from those of Asia Minor.

The Syrian Arc was upraised by folding in three stages: the first movement was in the uppermost Cretaceous (Upper Danian); the second in the Lower Miocene; the third and most important was in the Upper Miocene The crumpling was due, according to Dr Krenkel, to pressure from the south and east toward the Mediterranean. It was therefore in the opposite direction to that in the Dinaric-Taurus Arcs, which extend along the eastern side of the Adriatic, through Greece and the Archipelago to the southern chains of Asia Minor The general course of the Syrian Arc conforms closely to that of the Dinaric and Taurus Mountains, and both of the mountain arcs moved toward the great depression of the Eastern Mediterranean which lies between them.

J. W. GREGORY.

Permanent Magnets.

MR. S. EVERSHED read an important and valuable paper on permanent magnets to the Institution of Electrical Engineers on March 19. The paper gives the results of many years' research, and ought to prove of immediate value in improving the quality and cheapening the cost of high-grade permanent magnets In 1616 Barlowe wrote concerning the mediæval art and mystery of magnet making—"The compass needle, being the most admirable and useful instrument in the whole world, is so bungerly and absurdly contrived as no other." Although the permanent magnet has become an indispensable adjunct of modern engineering, yet industries rooted in tradition are generally backward, and magnet making is no exception

The hardening of iron and the making of steel were probably discovered accidentally. Metallurgists have found that ordinary pure iron exists in various allotropic forms depending on the temperature. At ordinary temperature it is called Alpha iron and is the commonest of all metals. Its specific heat at 0° C. is 0·1055 precisely, which is in excellent accord with theory. This specific heat gradually increases until about 750° C. The author calls this the precursor effect, as it indicates that the heat is not all expended in raising the temperature; some of it is doubtless expended in effecting a change of some kind in the structure of the iron. At about 770° C. Alpha iron begins to change into Beta iron, and the transformation is practically complete at 810° C.

Alpha iron is magnetic, Beta iron is entirely non-magnetic. As the molecule of Beta iron must be quite different from that of Alpha iron it is practically a new element. Throughout the narrow zone of temperature of 40° C Alpha and Beta molecules can exist together, and this explains the loss and recovery of magnetism in iron as shown by experimental curves. At between 918° and 920° C. Beta iron is converted into Gamma iron, and at between 1404° and 1405° C. Gamma iron becomes Delta iron, its specific heat suddenly increasing by 50 per cent. At 1528° C. pure iron melts. Assuming that specific heat is inversely proportional to atomic weight, it would follow that these varieties of iron should have atomic weights of about 56, 37, 41, and 27, which are the atomic weights of iron, chlorine, calcium, and aluminium. The molecules have not changed successively into the molecules of these elements, but they must have done something equally revolutionary.

The carbides used in manufacturing magnet steels dissolve freely in Delta, Gamma, and Beta iron, but

these kinds of iron are all non-magnetic. To make a magnet the steel must be magnetic, and consequently in the Alpha state. It is necessary, therefore, to heat the iron until it is in the Beta or Gamma state, dissolve a quantity of carbide in it, and then by plunging it into cold water make it return quickly to the Alpha state.

Nowadays carbon steel is seldom used for permanent magnets. Tungsten magnet steel is made similarly to carbon magnet steel, but half the carbide of iron is replaced by carbide of tungsten, the total content of carbon remaining unchanged The effect of replacing part of one solute substance by another is to increase the magnetic coercive force from rather less than 50 to slightly more than 70 When cobalt is used instead of tungsten the coercive force is increased to 180 From the point of view of the manufacturer, tungsten steel is generally the most attractive Carbon steel is 60 per cent more costly, and cobalt steel costs three or four times as much. Cobalt steel withstands demagnetising forces much more effectively than tungsten steel. If two permanent straight magnets, one of tungsten steel and the other of cobalt steel, were subjected to demagnetising forces equal to 20 per cent. of their coercive force, the tungsten magnet would lose 14 per cent. of its strength, but the cobalt magnet would only lose 3 per cent

The author has made many experiments on the loss of the coercive force in all kinds of " permanent " magnets. In a cobalt magnet, for example, the initial coercive force was 180, but after 4·4 years it had fallen to 161·8. The continued falling off in the coercive force of hardened magnet steel is attributed to the passage of carbide molecules out of solution Immediately after the hardening, the coercive force decreases by about 7 per cent. in the course of the first hundred hours, but after a year the rate of decay seems to settle down to a small steady value The author calculates that the whole of the surplus carbide in cobalt steel might pass out of solution in about seventy years, the steel then being completely softened. He has noticed, however, a seasonal oscillation in the value of the coercive force, the reason of which is still unexplained.

When manufacturing steel containing tungsten or cobalt for use in making permanent magnets, the greatest attention has to be paid to the heat treatment. The experiments described prove conclusively that if tungsten steel be heated to any temperature between 750° C. and 1214° C., and kept at this temperature for an appreciable time before hardening, its magnetic properties are weakened, the weakening increasing with the length of time the steel has been kept at the high temperature The deterioration of the steel goes on most rapidly when the temperature is 950° C. At 1200° C. the spoiling of the steel goes on very slowly, the coercive force falling only 0·4 units per hour. At 1240° C., however, which is only 26° above the danger zone, restoration of coercive force takes place at the rate of 15 units a minute. It is obvious, therefore, that great attention has to be paid to the temperature to which the steel is heated, before hardening.

This paper is a sequel to one the author read to the Institution in 1920, and together they give a very complete account of the modern theory and practice of magnet making. The results obtained by the British Scientific Instrument Research Association on the possibility of making magnets of complicated shapes by casting them with molten metal and then subjecting them to a suitable heat treatment are described. The method appears to be very promising and already cast magnets are on the market.

University and Educational Intelligence.

CAMBRIDGE —Particulars are now available of the Pinsent-Darwin Studentship in mental pathology, founded in 1924 by Mrs Pinsent and Sir Horace and Lady Darwin for promoting research into any problem which may have a bearing on mental defects, diseases or disorders. The Studentship is of the annual value of about 200*l.* and is tenable for three years in the first instance Candidates may be of either sex, and need not be members of the University of Cambridge. Applications must be sent before May 1 to the Secretary, Pinsent-Darwin Studentship, Psychological Laboratory, Cambridge

EDINBURGH —The following are among the honorary degrees to be conferred in July —LL.D. Brigadier-General the Hon Charles Granville Bruce, chief of the Mount Everest Expedition, Prof A S Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge, Prof Robert Muir, professor of pathology in the University of Glasgow, Principal C G. Robertson, University of Birmingham, Sir Harold J Stiles, emeritus professor (clinical surgery) in the University of Edinburgh

LEEDS —Mr J. Gordon has been appointed lecturer in bacteriology in succession to Dr Ross resigned An honorary demonstratorship has been instituted in the Department of Zoology, and Mrs H W. Swift appointed thereto

LONDON —In commemoration of the donation of 105,000*l.* made in 1914 by Sir Hildred Carlile, Bart, to the Endowment Fund of Bedford College, it has been resolved that the University chairs of English literature, Latin, botany, and physics tenable at the College shall henceforth be entitled the " Hildred Carlile " chairs

The following doctorates have been awarded: *Ph.D.* (*Science*), Mr. K C. D Hickman (Imperial College—Royal College of Science) for a thesis entitled " Studies in Adsorption, with special reference to the Washing of Photographic Products," and other papers, and Mr D. F. Stedman (University College) for a thesis entitled " The Liquid-vapour Equilibrium of the System Glycerine-water "; *D Sc.* (*Physics*), Mr. F Simeon (University College) for a thesis entitled " 1 The Carbon Arc Spectrum in the Extreme Ultra-violet: 2 Note on the Striking Potential necessary to produce a Persistent Arc in Vacuum," and other papers, and Mr. B. W. Clack (Birkbeck College) for a thesis entitled " On the Study of Diffusion in Liquids by an Optical Method "

ST ANDREWS —The Senatus Academicus has resolved to confer the honorary degree of LL.D. on the following, among others: Sir William Bragg, Fullerian professor of chemistry at the Royal Institution, and Director of the Davy-Faraday Research Laboratory, Prof. F. G. Donnan, professor of inorganic and physical chemistry in the University of London; Prof Etienne Gilson, professor of philosophy of the Middle Ages, Sorbonne, University of Paris, Mr. R. W. T. Gunther, fellow of Magdalen College, Oxford.

A COMPETITIVE examination for two scholarships at the Household and Social Science department of King's College for Women, namely, the Carl Meyer, 80*l.* a year for three years, and the Minor College, 40*l.* a year for three years, will be held on May 21. The latest date for the receipt of entry applications is May 18. They should be sent to the Secretary of the department, Campden Hill Road, W.8.

THE next election to the research scholarships of the Grocers' Company for the prosecution of original research in sanitary science will take place in May, and applications for them are invited until April 14. The scholarships are each of the annual value of 300*l.*, plus an allowance for apparatus and other expenses. They are tenable for a year, with the possibility of renewal for a second or a third year. Applications, upon a form to be provided, should be sent to the Clerk of the Company, Grocers' Hall, E.C.2

THE second session of the summer school for post-graduate mathematics, organised by the Extra Mural Department of the University of Manchester, will be held at University College, Bangor, on August 24–September 5. The object of the school, which is recognised by the Board of Education, is to afford facilities for advanced study in mathematics to teachers and others who have read mathematics for a university degree. The following three alternative courses are proposed: (*a*) Atomic structure and the quantum theory, by Prof. Sydney Chapman (Imperial College of Science, London); (*b*) theory of functions, by Prof. L. J. Mordell (University of Manchester); (*c*) higher geometry, by Mr. H. W. Richmond (King's College, Cambridge). Particulars may be obtained from Miss D. Withington, The University, Manchester. Application should be made at an early date, as the holding of the courses depends to some extent upon the number of applications received.

IN any college where a large staff is employed, the duties and interests cover a wide variety of subjects, and the results of research work are often scattered over technical journals and the proceedings of many societies, a procedure which fails to provide an adequate view of the work of the college as a whole. The authorities of the Royal Technical College, Glasgow, have been considering this matter, and have resolved to publish an official journal, which will contain records of the research work done in the college, and thus prove an incentive to junior workers in particular. A copy of the first number of the Journal of the college is now before us, and contains records of eleven researches conducted in the college, representing chemistry, metallurgy and engineering. The name of the editor does not appear, but he is to be congratulated upon the production, and especially upon the useful feature of printing a short abstract of each paper immediately under its title. The research activities of the college may be judged by the articles which appear in this issue. These include papers on some acyl derivatives of hydrazine; the formation and constitution of certain double salts with a review and criticism of van 't Hoff's theory; radio-active substances as indicators with a study of the adsorption of lead and bismuth by ferric hydroxide and the adsorption of thorium by basic ferric acetate and by barium sulphate by this method; the hydro-ferro- and hydrofern-cyanides of the organic bases and some applications; the separation of the components of petroleum with the view of utilising this commodity as a raw material for chemical industries; the iron-carbon diagram; the copper-zinc system; the petrological and chemical examination of slag and metal samples from a basic open-hearth furnace. These papers are followed by two on engineering subjects which occupy nearly one half of the issue; the subjects are the pipe loss in steam nozzles, and turbine wheel friction, on both of which the Royal Technical College has already given authoritative papers. The last paper deals with the structure and mode of life of the sulphur-bacteria and their value as indicators of pollution. The appearance of this Journal will be welcomed alike by science and engineering workers, and cannot fail to be beneficial to research workers in the college itself.

Early Science at Oxford.

April 6, 1686. Mr. Aston communicated amendments of ye Treatise *De Moventibus in Fluido*, and Mr. Ash sent a Demonstration of the 2d and 5th books of Euclide, and ye whole doctrine of proportion done more briefly than heretofore; for both which ye Secretary was ordered to returne ye thankes of ye Society.

April 7, 1685. A very rationall Discourse concerning Weather, written some time since by Dr. Garden (by way of Letter to his Friend Mr. Scougall) was read. The Society ordered their thankes to be returned, both to Dr. Middleton and to Dr. Garden, for the communication of so considerable a piece of Philosophy. One passage in Dr. Garden's discourse deducing the Rise and Fall of Vapours from their weight in respect to that of the Air, (intimating, that ye Vapours arise, when specifically lighter, and fall when specifically heavier, than the Air). Mr. President, not denying this to be true, added hereunto, that Subterraneal heats, or other ferments, may bear some part in producing this effect; as impelling upwards those Vapours, which, being specifically heavier than the Air, fall again in a little time. An instance of which he gave in ye boyling of Water, where the vapours are forced upwards by the fire placed under the Vessell, and, having lost that impetus, which raised them, and being intensively heavier than the Air, sink down again.

A Letter from Mr. Aston mentioned a Catalogue of Rarities, brought from Ceylon, by Dr. Heerman of Leyden, and preserved according to a peculiar way known to him. A Transcript of this Catalogue is desired. The remaining half of Mr. Leewenhoeck's Letter concerns the Salts of Wine, Vinegar &c, was read.

April 8, 1684. Mr. Ballard discoursed concerning ye Magnetism of Drills, being by way of answer to a letter of Mr. Aston's on that subject, dated March ye 15th. Six or seven severall Drills were caused to be made before my face; and ye bit, or point, of every one became a North Pole, onely by ye hardning, before they ever came to be workd either in Iron, or any other Matter. That peices of plain Iron in shape like Drills (that is something long, and small,) do always change their Poles, as they are inverted (ye end downward being over ye North Pole) he finds not allways true. Mr. Hunt's experiments on drilling were repeated, but his conclusions were found not to be always confirmed. Mr. Bernard read a letter of his to Dr. Huntingdon, concerning ye place of ye fixed starrs, as treated of in severall Arabic authors, given to Merton College Library by ye Doctor.—There being some discourse concerning ye insipid tast of ye Ice of Seawater, it was queried, whether sea-water might not be sweetned, and rendred serviceable.

April 10, 1688. The Standards of the wine, corn, and Ale Gallons, kept at St. Marys, were examined by Dr. Bernard, Mr. Walker and Mr. Caswell. They were filled with Pump-water, and then weighed. The weights compared with a former experiment by this Society of the weight of a cubic foot of water, give the quantitys of these Gallons in cubic Inches, &c.

Wine—Gallon -	232 : 00	cubic Inches.
Corn—Gallon -	270 : 43	
Ale—Gallon -	280 : 15	

The variation of the Needle at Oxford July 22nd 1687 was found to be 5°20′ West.

Dr. Bernard presented the Society with his book *De Ponderibus et Mensuris Antiquis*; for which the Society returned their thanks.

Societies and Academies.

LONDON.

Royal Society, March 26.—O. W. **Richardson** and T. **Tanaka**: Regularities in the secondary spectrum of hydrogen. It has been possible to arrange 123 additional lines provisionally in 22 series. Three of these form a PQR combination. The present indications are that the moments of inertia of the emitters are spread fairly well over a range extending from the high value deduced from the PQR combination found previously to a value somewhat below the lowest value which has been deduced from Fulcher's second band. This involves an extreme variation by a factor of almost six in the moments of inertia.—S. **Chapman**: The lunar diurnal magnetic variation at Greenwich and other observatories. The systematic changes of magnetic declination at Greenwich, during the course of the lunar day, have been determined from hourly records extending over 63 years. This and other magnetic elements have been similarly studied, using shorter series of data, for the observatories of Batavia, Zikawei, and Pavlovsk. The character and magnitude of the lunar daily changes depend on the following factors: the position of the sun relative to the moon, the position of the sun relative to the equator, the distance of the moon, the sunspot epoch, and the general state of magnetic activity upon the earth—the latter being connected with particular disturbed regions on the sun's surface. The lunar daily magnetic variation varies much less with sunspot epoch, and much more with the magnetic activity, than does the solar diurnal variation. It is concluded that the lunar influence on the earth's magnetic field, exerted through the agency of the lunar tide in the earth's atmosphere, is most efficient in the polar regions.—H. T. **Flint**: A general vector analysis with applications to electrodynamical theory. The vector analyses in use, as a rule, are concerned with quantities represented by straight lines, and the space to which they are applicable is Euclidean. An account is given of an analysis in which a vector is represented by

$$\delta a' = \sum_n i^n \delta x^n.$$

The vector is of infinitesimal length and δx^n represents a component measured in any system of co-ordinates. In any kind of space, Euclidean or not, in which a point B has co-ordinates $(\delta x^1, \delta x^2, \ldots, \delta x^n)$ with respect to A we shall regard $\delta a'$ as denoting a definite quantity, whatever the system of co-ordinates. In this space we shall suppose the geodetics unique and shall regard the geodetic arc joining A and B as the geometric representatives of the vector $\delta a'$. So far as possible the notation will be similar to that of Gibbs' vector analysis. The notation may be applied to space of any dimensions, but four-dimensional space is taken as fundamental. In many cases it is possible to employ a notation that leaves the formulæ of ordinary vector analysis almost unchanged, and formulæ of the restricted principle can be carried over to the general principle by merely applying rules of generalised vectors.—Miss M. O. **Saltmarsh**: The spectra of doubly and trebly ionised phosphorus (P III and P IV). The series system in the spectrum of doubly ionised phosphorus is a doublet system in accordance with the spectroscopic displacement law. Three members of the triplet series of the spectrum of trebly ionised phosphorus have been identified. For three groups of elements, each having its own characteristic electron structure, the sharp terms are greater than the diffuse terms with the same Rydberg number for the neutral and singly ionised element, but for higher stages of ionisation the diffuse terms are greater than the sharp.—D. M. **Wrinch** and J. W. **Nicholson**: Laplace's equation and the inversion of surfaces of revolution.—T. R. **Merton** and J. G. **Pilley**: On experiments relating to the spectrum of nitrogen. When helium at about 30 mm. pressure containing a very small quantity of nitrogen is excited by feebly condensed discharges, the arc spectrum of nitrogen is developed, and under these conditions is completely isolated from the spark spectra. The arc spectrum of nitrogen is not developed in the presence of an excess of argon under the same conditions in which it appears in the presence of helium. Special precautions have to be taken to ensure the purity of the gases. When nitrogen is excited by electron impacts there appears to be a direct transition as the energy of the impacts is increased from the negative band spectrum to the spark spectrum, which would imply that the rupture of nitrogen molecules is generally into ions rather than neutral atoms.—T. H. **Havelock**: Studies in wave resistance; the effect of parallel middle body. The ship is altered by inserting varying lengths of parallel middle body between the same bow and stern. The main problem is the study of the equivalent wave-making length of the ship, and its variation with velocity and with the length of parallel middle body.—T. **Tanaka**: Wave-lengths of additional lines in the many-lined spectrum of hydrogen. Some 560 new lines in the secondary hydrogen spectrum have been measured. Incidentally it was necessary to make measurements of a considerable number of lines in the oxy-hydrogen band spectrum.—H. S. **Taylor**. A theory of the catalytic surface. A catalytic surface seems to be composite, of atoms in varying degrees of saturation in a crystal lattice. The saturation varies from that in a plane surface to those which are only held to the surface by a single constraint. It is by this constraint that these outermost atoms differ from gaseous atoms. Thus several molecular species, for example, hydrogen and an unsaturated molecule, may be attached to the same atom of catalyst.—E. F. **Armstrong** and T. P. **Hilditch**. A study of catalytic actions at solid surfaces. Pt. XII. Some observations relative to those particles of a catalyst which participate in chemical change. The rate of decline of activity of several nickel catalysts in the presence of varying concentrations of impurities characteristic of natural fatty oils has furnished evidence supporting Taylor's hypothesis (*v.* above). The active nickel atoms seem to be actually detached from their neighbouring metallic atoms during the moment in which catalytic change is effected. Pt. XIII. Some factors controlling selective hydrogenation with particular reference to certain terpene derivatives. Whilst adjacent (conjugated) ethylenic linkages are converted completely to a saturated system, two separate ethylenic linkages are hydrogenated consecutively, one double bond disappearing completely before the other is attacked: acetylenic linkages are transformed to the saturated compounds with little or no production of the corresponding ethylenic compound. Similarly, the hydrogenation of esters or glycerides of polyethylenic higher fatty acids (but not the free acids themselves) is markedly selective, and the same applies to diethylenic derivatives of the terpene series. Selective hydrogenation, observed by ourselves and by Vavon, in compounds such as carvone, limonene, citral, geraniol, and linalool, is determined mainly by (i) degree of substitution of ethylenic carbon atoms, and (ii) proximity to one or other double bond of a carbonylic or hydroxylic group. It is also deduced from these results that citral, geraniol, and linalool all contain the grouping $(CH_3)_2C=CH—$. Selective hydrogenation is of considerable importance in relation to the general theory of catalysis at a solid surface.

Royal Anthropological Institute, February 10.—J. Reid Moir: Further discoveries of Early Chellean flint implements from the Cromer Forest Bed of Norfolk. The principal site investigated exists at East Runton, where, upon the foreshore exposed at low water, is a bed, averaging 18 inches in thickness, resting upon the chalk and very strongly impregnated with salts of iron. The deposit is being slowly broken up by modern sea action, and this results in the formation of a flint bed of a precisely similar character to that present upon the foreshore at Cromer. The accumulation represents in all probability the basal layer of the Cromer Forest Bed strata From East Runton, Mr Sairn of Cromer has found a number of Forest Bed mammalian remains, including *E. meridionalis*, *E antiquus*, *Rhinoceros etruscus*, *Bison bonasus*, *Equus stenonis*, *Hyæna crocuta*, *Trogontherium cuvieri*, and numerous remains of the Cervidæ The hand-axes recorded at East Runton and Cromer show that the pieces of flint from which they were made were struck off larger masses of flint, some of which were "prepared" by flaking beforehand The evidence at East Runton establishes the fact of the occurrence of Early Chellean hand-axes in a bed at the base of the Cromer Forest Bed series of deposits, and beneath the glacial boulder clay of the Scandinavian ice-sheet, representing the second glacial period of East Anglia. It is highly probable that the specimens found upon the foreshore at Cromer were derived from a similar deposit to that still existing at East Runton.

February 20.—L. H Dudley **Buxton**: The Stoney Indians of the Bow River, Alberta. The Stoney Indians are a branch of the Dakota Sioux, from whom they separated shortly before 1640 After leaving the parent stock they joined the Crees and gradually moved in a north-westerly direction. The reserve on which they now live lies on both sides of the Bow River, in southern Alberta, at an altitude of over 4000 feet above sea-level, in the foothills of the Rockies. The country is hilly and much of it is covered with grass and, in places, low scrub. The area of the reserve is just under 140 square miles, of which fifty acres only are cultivated. The total Indian population is just over six hundred. The Stoneys are divided into three bands, which are not endogamous, but the tribe, apart from a certain admixture of Cree blood, have kept themselves very much from outside contact. They are typical Plains Indians They are very averse from agriculture, but hunt and trap at the right season and do a certain amount of trading. Although they are mostly nominal Christians, a number of the old customs, notably the Sun Dance, are still retained. The Stoneys seem in their physique to resemble closely the Siouan peoples to whom they are linguistically allied, but the most close resemblance is with the Blackfoot.

Linnean Society, February 19.—Miss A. Lorrain Smith Templeton's drawings of lichens and fungi. John Templeton (1766–1825) was well known to the botanists of his day, more especially in Ireland. Taylor states in a note to the section *Lichenes* in the "Flora Hibernica" (1836) "The foregoing account of the lichens of Ireland would have been still more incomplete, but for the extensive collections of our lamented friend, the late Mr. John Templeton of Cranmore, near Belfast." Templeton entered on the scientific study of botany in 1790. His last paper seems to have been on peat-bogs, and was contributed to the Geological Society in 1821. Several manuscript volumes of his Hibernian flora with coloured drawings are preserved in the Belfast Museum.—J. **Burtt-Davy**: The tropical element in the arborescent flora of the Transvaal. The geographical distribution of 647 kinds of trees and allied shrubby plants was discussed. About 30 per cent of these are endemic to the Transvaal and 70 per cent. are "wides." The percentage of endemics is only about two-thirds that of the endemics of all Transvaal phanerogams, suggesting that they represent types of vegetation older than many of the herbaceous types. Fully 90 per cent of the wides are tropical or subtropical; the temperate element is very small. There is evidence in a limited area of the evolution of a recent warm-temperate flora (through recent elevation of the land-surface) replacing an older tropical and subtropical flora. Islands and reefs of older floras are left stranded where climatic conditions permit them to persist; these are not homogeneous, but represent different migration periods. Several cases are cited of strictly Northern Hemisphere genera migrating into South Africa, *e.g.* Salix, Dianthus, and Juniperus, none of which can have migrated from south to north. The highway of migration southward has been the great eastern mountain-range, owing to its favourable climatic conditions (relative absence of drought periods, etc.). The great central plateau has acted as a (recent) barrier to migration, probably owing to relatively low rainfall and periodic drought.—R R **Gates**: A virescent Delphinium The numerous flowers showed little variation, the sepals were large and baggy, the spur of the posterior sepal being very short, forked at the tip, and very late in developing. The petals were very much reduced and without spurs or nectaries The androecium was unaltered and the pollen normal. The carpels were long, curved, and without stigmatic surfaces Virescence is frequently inherited as a Mendelian recessive, but often with complications, and the whole phenomenon deserves further genetic study.

Geological Society, February 25.—A. H. **Cox**: (1) The geology of Cader Idris (Merionethshire). Cader Idris is an escarpment of Ordovician igneous rocks south of the Harlech Dome. The strata have a general southward or south-eastward dip of about 40°, and the succession is given. The volcanic rocks have a much greater time-range than had been proved hitherto. The four volcanic groups are separated one from the other by sediments of thicknesses so considerable that each represents a distinct episode. The main structures have a north-east to south-west trend; but there is also a regular system of north-and-south minor folds that often cause a marked deflexion of outcrops This minor folding was operative in pre-Ordovician, Ordovician, and post-Silurian times. (2) The dissection of pitching folds. By altering the inclination of the plane of dissection across a pitching fold, outcrops can be made to take any desired curve, either concave or convex. In a pitching anticline the curves will have a downward convexity when the inclination of the dissecting plane is less than the angle of pitch, but an upward one when the direction of inclination of the dissecting plane is opposed to that of the pitch. There must, therefore, be some intermediate position in which the outcrop "curve" is such that its projection on the map appears as a straight line, and the outcrop crosses the fold without apparent deflexion. Such deceptive projections are liable to occur in districts of high relief.

PARIS.

Academy of Sciences, February 16.—A. **Lacroix**: A new type of eruptive alkaline rock.—G. **Kowalewski**: Plane groups with two fundamental infinitesimal transformations.— — **Angelesco**: Polynomials con-

nected with those of M. Appell.—André **Roussel**: Semi-continuity.—A. **Alayrac**: Study of the *vol plané* in a wind of oscillating direction and in an oscillatory wind of short period.—André **Metz**: The entanglement of the ether and the aberration of the stars. The conclusion is drawn that the aberration of the stars, as shown by experiment, is incompatible with the hypothesis of the entanglement of the ether by the earth.—Louis **de Broglie**: The natural frequency of the electron.—A **Marsat**: The verification of reflectors for the projectors of motor-cars. A description of a rapid method for determining the dimensions of the caustic curves of reflectors.—A. **Leduc**: Molecular association and the equation of state of gases.—H. **Buisson** and C **Jausseran**: The spontaneous reversal of the lines in the spectrum of neon. In a neon spectrum, lines which are simple when viewed through a short length of gas show reversal when viewed through a longer length. As a consequence of this spontaneous reversal, neon lines are not so useful in determining standards of length as has been supposed.—André **Broca** The rational mounting of stringed instruments. Modifications in mounting are described which have been proved practically to lead to improved tone and quality.—Robert **Castagné**. The radioactivity of some springs of Alpine stations (Aix-les-Bains, Challes-les-Eaux) in the Pyrenees (Bagnères-de-Bigorre) and the Cévennes (Lamalou-les-Bains, Balaruc-les-Bains, Les Fumades) and of the natural gases of Vergèze (Gard), of Hérépian and Gabian (Hérault). The results of the measurements given show the high radioactive power of the large springs at Aix-les-Bains, the important radioactivity of the waters in the Pyrenees, and the feeble radioactivity of the springs in the Cévennes and on the Mediterranean coast.—René **Audubert** and Mlle Marguerite **Quintin**: The mechanism of adsorption of ions.—F **Wandenbulcke**: The rapid estimation of sulphuric acid in waters.—A. **Kling** and Mme. A **Lassieur**. The separation of zinc and nickel by sulphuretted hydrogen Since the presence of sulphuretted hydrogen interferes with the working of the hydrogen electrode, the quinhydrone electrode and with coloured indicators, it is necessary to remove this gas completely from solutions, either by boiling or by passing air, before determining the acidity. For the quantitative precipitation of zinc as sulphide without separation of nickel the P_H must be between 1·35 and 2.—Georges **Denigès**: The alloxantin reagent, of very general application, for ferric iron.—J. F. **Durand** and R. **Naves**: The action of hydrogen peroxide on the magnesium arylamines. By using an anhydrous ethereal solution of hydrogen peroxide, phenylhydroxylamine can be prepared from C_6H_5. NH MgBr with a yield of about 80 per cent.—Paul **Jodot**: Contribution to the petrographic study of *chailles*.—Jean **Piveteau**: The age of the lowest layers of the sedimentary strata of the south-west of Madagascar, between Onilahy and Mangoky.—J. **Savornin**: The cretaceous basin of the Haute-Moulouya.—R. **Bureau** Atmospherics: their classification and their thermodynamical properties.—L. **Lutz**: The culture of Hymenomycetes fungi in artificial media.—V **Vincent**: The action of the carbonates of the alkalis and alkaline earths on the acidity of soils. The best substance for neutralising acidity in soil, in spite of its insolubility, is calcium carbonate, because it can be employed at any period without endangering the seed, and is also safer for light soils than quicklime.—Mlles. J. **Lelièvre** and Y. **Ménager**: The application to *L. flexicaulis* of the method of analysis by combustion.—L. **Hervieux**: The presence of silica in incinerated histological sections. Remarks on a note by M. A. Policard. Claim to priority.—A **Maubert**, L. **Jaloustre**, P. **Lemay**, and G. **Andreoly**: The catalytic properties of bismoxyl. The tartrobismuthate of potassium and sodium precipitates the catalase of hepatic extracts: the precipitate formed shows great activity towards hydrogen peroxide.—A. **Rochon-Duvigneaud**, E. **Bourdelle**, and J. **Dubar**: Apparatus for the determination of the visual anatomical field by the method of the trans-scleral image.—E. **Hédon**: Life without the pancreas. The effects of the suppression of the treatment by insulin in the dog completely deprived of the pancreas diabetic coma, its cure by sodium bicarbonate and insulin.—Raoul M. **May**. Relation of the nerves to degenerescence and the regeneration of the gustative papillæ.—Jacques **Pellegrin**: African fishes of the family of the Phractolœmideæ.—R. **Argaud**: The nerve terminations in human cancer.—H **Bordier**: Experiments in medullary radiotherapy This treatment has produced marked improvement, and in some cases has cured infantile paralysis. The technique is given in detail.

ROME.

Royal Academy of the Lincei, January 4.—V. Volterra in the chair.—B. **Grassi** Androphylic and androphobic gnats of Legendre.—Alfonso **Herrera**: Photosynthetic theory of the origin of life and production of organic forms with metaformaldehyde Under certain conditions formaldehyde undergoes polymerisation into metaformaldehyde, which separates in a pseudo-crystalline mass composed of microscopic cell-like and amœboid forms, the silica present as impurity in commercial formalin apparently plays a part in this phenomenon.—Ferruccio **Zambonini** and Guido **Carobbi**. Isomorphism between tervalent thallium and rare-earth metals. As would be expected from the atomic structure proposed by Bohr, the isomorphism existing between compounds of tervalent thallium and those of the rare-earth metals is of limited range.—G **Bisconcini**: Imperfect flexibility of ropes.—Mario **Crenna**. Observations on the variations in the latitude of Campidoglio.—R. **Magini**: Behaviour of empty [so-called "sandwich"] cathodes in the electric discharge at low pressure.—Paolo **Straneo**. Expression of hereditary phenomena. Deformation of materials is discussed in relation to previous stresses.—Emanuele **Quercigh**: Bismuthinite Crystallographic measurements of artificial crystals of bismuthinite lead to the axial ratios, $a : b : c = 0{\cdot}985 : 1 : 1{\cdot}004$.—Francesco **Ranfaldi**: Ethyl ester of phenyl-*p*-nitrocinnamic acid This substance forms crystals belonging to the prismatic class of the monoclinic system, the crystallographic constants being $a : b : c = 1{\cdot}65679 : 1 : 1{\cdot}83480$, $\beta = 69° 29'$; Scacchi's results for the corresponding methyl ester are modified to: $a : b : c = 1{\cdot}82871 : 1 : 0{\cdot}91775$, $\beta = 69° 29'$.—Umberto **D'Ancona** Investigations on the growth and sexual maturity of *Alosa finta* (Cuv.).—Primo **Dorello**: Function of the digitated glands in the genus Helix.—L. La **Face**. Observations on the nutrition of *Culex pipiens*.—Luisa **Volterra**. Further notes on the variability of the pelagic daphnias of Lake Nemi.—N. **Passerini**: Influence of the quality of the food on the growth of the larvæ, and on the metabolism, of *Tenebrio molitor L.*

VIENNA

Academy of Sciences, January 15.—L. **Siegl**: Communication from the Radium Institute, No. 174. The quantitative measurement of radium emanation in the guard ring plate condenser. In an attempt to make the radium standard and normal solutions superfluous, a measurement was made of the ionisation

stream which maintains the radium emanation and its successive products in equilibrium. An accurately made air-tight guard ring plate condenser was used as measuring chamber, since it alone is open to complete theoretical treatment. With regard to the three α-radiators (emanation, radium A, and radium C) only, observation and calculation gave a more than one per cent agreement beyond 4 cm plate distance, but at small plate distances a greater disagreement. An absolute measure of radium emanation and hence of radium itself can be obtained from the saturation current.—G. **Halledauer**: Communication from the Radium Institute, No. 175. A method of measuring the smallest quantities of emanation and its application to the determination of the radium content of some meteorites. The charge method can be freed from certain errors if the ionisation chamber is completely separated from the electrometer whilst charging, and only at the end and for measurement brought into brief contact with it. Emanation quantities of 10^{-14} Curie may be determined with certainty. For five iron meteorites an average of $0{\cdot}55 \times 10^{-12}$, and for five stone meteorites $6{\cdot}6 \times 10^{-13}$ gm. radium per gram, was found, in practical agreement with other authors.—H. H. **Handel-Mazzetti**: New Chinese plants, descriptions continued.—A. **Limberger**: Symbiosis of Anabæna with Azolla.

January 22.—H. **Handel-Mazzetti**: Map of a journey in the Chinese province of Hunan. H. Witt's surveys including the latitude of Wukang and of Dsingschou were utilised. Dr. H. Mazzetti as a botanist had no astronomical survey instruments, but in his survey emphasised the nature of the country within a wide range of his route, producing a general route map of scale 1 : 300,000 and maps of 1 : 100,000 near Hsikwangshan and Yunschan.

Official Publications Received.

United States Department of Agriculture: Bureau of Agricultural Economics. Atlas of American Agriculture. Prepared under the Supervision of O. E. Baker. Part 1. The Physical Basis of Agriculture. Section E: Natural Vegetation. Grassland and Desert Shrub, by H. L. Shantz; Forests, by Raphael Zon. Pp. 29. (Washington: Government Printing Office.) 50 cents.

Department of the Interior. Bureau of Education. Bulletin, 1924, No. 18: Introduction of Algebra into American Schools in the Eighteenth Century. By Jane Genevra Simons. Pp. vi+80. (Washington: Government Printing Office.) 15 cents.

The National Benzole Association. Second Report of the Joint Benzole Research Committee of the National Benzole Association and the University of Leeds. (Presented March 18th, 1925.) Pp. 246. (London: National Benzole Association.)

The Indian Forest Records. Vol. 11, Part 1. The Constituents of some Indian Essential Oils. By John Lionel Simonsen. Parts 14-15. Pp. 9. 3 annas; 4d. Vol. 11, Part 3: Regeneration with the Assistance of *Taungya* in Burma. By H. R. Blanford. Pp. 41+10 plates. 1.4 rupees; 2s. (Calcutta: Government of India Central Publication Branch.)

Transactions of the Geological Society of South Africa. Vol. 27, January to December, 1924. Pp. iv+77+6 plates. (Johannesburg.) 42s.

Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussion on Papers read during 1924. To accompany Vol. 27 of the Transactions, January to December, 1924. Edited by the Hon. Secretary. Pp. iii+xiii. (Johannesburg.)

Department of Commerce. Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 497: Thermal Expansion of Aluminium and various important Aluminium Alloys. By Peter Hidnert. Pp. 697-731. (Washington: Government Printing Office.) 15 cents.

Unemployment and the Calcutta University Propaganda for a Solution by Educational Colonies, Homecrofting and Homecrafting. Two Series of Articles by Capt. J. W. Petavel. Pp. xvi+vii+90+12. (Calcutta: "Capital," Ltd.) 8 annas; 9d.

New South Wales. Department of Mines: Geological Survey. Bulletin No. 10: Silica. By L. F. Harper. Pp. 19+10 plates. 1s. Bulletin No. 12: Coke. By L. F. Harper. Notes on By-Products by H. P. White. Pp. 45+9 plates. 1s. 9d. Bulletin No. 14: Asbestos, Emery, Fluorspar, Fuller's Earth, Graphite, Phosphates, Talc, and Soapstone. By H. G. Raggatt. Pp. 81. 1s. Bulletin No. 15: Diatomite, Siliceous Earths and Sands. By E. J. Kenny. Pp. 18+2 plates. 1s. (Sydney: Alfred James Kent.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 4, March 12. Pp. 481-600. (Cambridge: At the University Press.) 7s. 6d. net.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 30: Geology of the Outer Hebrides. Part 2: South Uist and Eriskay. By Prof. T. J. Jehu and R. M. Craig. Pp. 615-641+5 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 5s. 6d.

Proceedings of the London Mathematical Society. Second Series. Vol. 23. Pp. lxxi+524. (London: Francis Hodgson.)

Ministry of Public Works, Egypt. Physical Department Paper No. 16: Metallic Spirit-Levels. By E. B. H. Wade. Pp. 9+4 plates. (Cairo: Government Publications Office.) 5 P.T.

The Annual Report of the Gresham's School Natural History Society, 1924. Pp. 14. (Holt, Norfolk.)

Diary of Societies.

SATURDAY, APRIL 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. H. Ashworth: The Nervous System and some Reactions (II.): Of Marine Annelids and Earthworms.

BRITISH ASSOCIATION OF MANAGERS OF TEXTILE WORKS (at Textile Institute, 16 St. Mary's Parsonage, Manchester), at 6.—F. A. Tomlinson: The Outside Growths of Cotton.

IPSWICH AND DISTRICT NATURAL HISTORY SOCIETY (at Ipswich).—J. Reid Moir: The Antiquity of Man in Ipswich (Presidential Address).

MONDAY, APRIL 6.

ROYAL SOCIETY OF MEDICINE (War Section), at 4.30.—Annual General Meeting.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. E. Ash: Psychotherapy. Mind in Curative Action.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—E. R. Matthews: Problems in Designing and Constructing Sea Defence Works.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. Jessie White: Scientific Pedagogy.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. Collins and others: Discussion on Insulation Problems in High-voltage Engineering.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—P. Leon: Æsthetic Knowledge.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Royal Society of Arts), at 8.—Prof. W. A. Bone: The Constitution of Coal.

SURVEYORS' INSTITUTION, at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major-Gen. Sir Percy Cox: A Journey behind Muscat to the Jebel Akdhar.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre).—S. T. Allen: Radiators and Heating, with special reference to Material.

TUESDAY, APRIL 7.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—F. G. S. Whitfield: The Relation between the Feeding habits and the Structure of the Mouth-parts in the Asilidæ (Diptera).—O. Thomas: The Mammals obtained by Mr. Herbert Stevens on the Sladen-Godman Expedition to Tonkin.—W. M. Le Gros Clark: The Skull of *Tupaia minor*.—Dr. R. H. Hunter: The Extensor Muscles in the Hind-foot in Mammals.

INSTITUTE OF MARINE ENGINEERS, at 6.30.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—Annual Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. E. Lamplough: The Manufacture of Optical Glass (Traill-Taylor Memorial Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.15.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (Jointly with the Chemical Engineering Group) (at Birmingham University), at 7.15.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at 207 Bath Street, Glasgow), at 7.30.—E. A. Watson: The Economic Aspect of the Utilisation of Permanent Magnets in Electrical Apparatus.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—W. I. Hay and D. McArthur: Canadian Bulk Cargo Vessels on the Great Lakes.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—Annual Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. H. S. Stannus: Some Types of Natives from Nyasaland, Normal and Abnormal.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—R. Craig Rodgers: The Organisation and Equipment of X-ray Rooms arranged for Private Radiologists.—G. T. Loughborough: Acute X-ray Burns.

WEDNESDAY, APRIL 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A. N. Kriloff: Sir Isaac Newton's Formula for the Attraction of a Spheroid on a Point of its Axis.—Dr. J. H. Jeans: A Theorem of von Zeipel on Radiative Equilibrium.—Prof. H. H. Turner: Note on the 284-year Cycle in Chinese Earthquakes.—Royal Observatory, Greenwich: Characteristic Movements of Sunspots.

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—H. C. Atkinson: Home-made Wireless Components and Sets.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Wolverhampton).

THURSDAY, APRIL 9.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre, Dublin) (at Trinity College, Dublin), at 7.45.—P. J. Hayes: Automatic Telephony.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 6 St. Martin's Place, W.C.2.) at 8.—B. D. Porritt: Some Problems of the Paint and Rubber Industries.

INSTITUTE OF CHEMISTRY (Liverpool Section) (at St. George's Restaurant, Liverpool).



SATURDAY, APRIL 11, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2893, VOL. 115]

The Universities and International Relations.[1]

AT a meeting of the British Academy held on February 25, Lord Balfour, Dr. J. W. Mackail, Sir Henry Newbolt, and Sir Rennell Rodd spoke in support of the endowment fund appeal of the British Institute of Florence. The publication of reports of these speeches has attracted general attention to the enormous importance of cultural relations between civilised peoples in view of what is to-day the supreme interest of European civilisation—the establishment of conditions of genuine and enduring peace and goodwill between the nations. Universities are concerned with these relations, first as subjects of study and research, and secondly as responsive to influences which the universities can and do exert on them. It is mainly the latter aspect with which we are at present concerned, but limitations of space prevent more than a passing reference to the influence of vacation courses for foreigners.

Year by year visitors from nearly every civilised nation come to study in British universities. Since 1920 a census has been taken annually in October of students from other countries in the universities and university colleges of Great Britain and Ireland, and it has been ascertained that their total number at that season of the year is between four and five thousand. It has varied but little from year to year. Most of them come at an age at which, whatever its prejudices, the mind is receptive to new impressions. They come eager to learn, many of them hold scholarships awarded on the ground of exceptional capacity for learning, and many assume, after they have returned, leading positions in politics, administration, education, commerce, and industry in their own countries. The character of the impressions they receive is, therefore, a matter of no small importance. A very telling phrase, indicative of the importance of such impressions, was used by a professor of Harvard medical school when, speaking as exchange professor at Berlin in 1912, he described how, owing to his studying in a German university, he had become an "intellectual subject of Germany."

The universities of Great Britain and Ireland receive also from time to time university teachers from other countries. Such visits are generally for the purpose of delivering one or two lectures, and accordingly brief. In the few cases in which they extend over a whole term and the visitor has opportunities of entering fully into the life of the university, as in recent exchanges between

[1] *The Educational Record* (Quarterly Journal of the American Council on Education, Washington, D.C.), January 1925,—article on International Relations, by Dr. D. A. Robertson. "Syllabus on International Relations," by Dr. P. T. Moon (The Macmillan Co., 1925, pp 276), issued by the Institute of International Education, and to be followed shortly by a companion volume designed to appeal to the general reader as well as the college student. *Documents concernant l'expansion scientifique et universitaire de la France* (Paris, Les Presses Universitaires de France, 1923).

Bâle and Cambridge, Bâle and Manchester, Cape Town and Liverpool, and Harvard and Oxford, they are capable of contributing substantially towards the promotion of good feeling between the countries which they represent.

The number of British students who resort to foreign universities for study and research has not been ascertained Apart from attendance at summer vacation courses in language and literature, it is probably not large. During the past few years, however, a rapidly increasing flow of British students to the United States has been created by the institution of a number of fellowships and scholarships, notably those of the Commonwealth Fund, and the Laura Spelman Rockefeller, the Frances Riggs, the H P. Davison, the Jane Eliza Procter, and the Clarence Graff foundations. When these are in full operation they will maintain some seventy British students in American universities

During the War we were roused to a perception of the importance of fostering cultural relations with other countries. For a time "propaganda" was a word to conjure with, and the things for which it then stood were given a recognised place in our defensive armoury. Plans were worked out in detail for establishing a book distribution depot and a number of institutes in Continental countries, for encouraging the study of the English language and literature. These plans were about to be put into execution when the War came to an end, and, in the general retrenchment of establishments which ensued, they were hastily abandoned as being superfluous in time of peace With the single exception of the British Institute at Florence, which is entirely independent of Government support, we have no establishments in European countries charged with the duty of diffusing knowledge of British civilisation.

Another war-time plan with similar objectives was devised by Lord Balfour in consultation with the universities of the United Kingdom in May 1918. This plan, for sending a Universities Mission to the United States, did not depend on the creation of any official machinery and was forthwith carried into effect. The missionaries sowed their seed and left it to thrive or perish as might be, bringing back with them a great store of knowledge of American universities, in the acquisition of which they had established many friendly personal relations. The precedent thus set was followed by missions, similar but on a smaller scale, to France and to Belgium in 1919, and a conference of British and Swiss universities at Bâle in 1922.

Although it was no part of the plan for the Mission to the United States to create any permanent organisation, Lord Balfour took the opportunity of pressing upon the universities the desirability of an "organ of expression" which should, among its other functions, represent them in their relations with the universities of other nations. The suggestion bore fruit in the constitution of a standing committee of the executive heads of the universities of Great Britain and Ireland, the existence of which facilitated the organisation of the later missions.

As a result of discussions arising out of the report of the Mission to the United States, a committee of the Universities Bureau was formed for the purpose of promoting interchange between teachers and students of the home universities and those of the universities of the United States and also of other parts of the world. With no funds at its disposal, and no prospect of obtaining any to meet the expenses incidental to such interchanges, the committee could not be expected to achieve much: nor, in fact, did it.

In matters of this kind, countries with autonomous universities are at a disadvantage compared with those in which the universities are controlled by the State, as in France and Italy. In March 1919 the Ministers of Public Instruction of these two countries concluded an agreement for the organisation of exchanges of professors and students "afin de rendre les relations intellectuelles des deux pays plus étroites et de mieux faire connaître de part et d'autre leur développement littéraire, scientifique et pédagogique." Later in the same year, agreements with the Ministers of Public Instruction in Rumania and Jugo-Slavia provided for seconding French professors for service in those countries. Agreements made by the French ministry in 1921–1923 with Belgium, Luxembourg, Poland, and Czecho-Slovakia provided not only for systematic interchange of professors and students and reciprocal recognition of studies, diplomas, and professional service, but also for the setting up of permanent advisory commissions to ensure constant consultation and collaboration in the domains of scientific, literary, artistic, and pedagogic activity. Grants of money amounting to several millions of francs were obtained from the French treasury for bursaries and for remission of fees to enable foreign students to study in France

It has been pointed out already that as soon as the War was over, the plans made for establishing British institutes in foreign countries were abandoned, on the ground that their expense was no longer justifiable. In France other counsels prevailed, a higher value being placed on such services. The Ministry of Foreign Affairs, through its Service des Œuvres françaises à l'étranger, and the Ministry of Public Instruction, through its Service de l'expansion universitaire et scientifique, have co-operated with professors and other savants, university councils, comités de patronage d'étudiants, and various associations, in a strenuous and sustained effort to make French culture appreciated by foreigners, an effort financed largely by the State.

Branches of the Office National des Universités et Écoles Françaises have been established in London and New York; the Instituts Français at London, Florence, and Madrid have been maintained, and new institutes opened at Naples, Barcelona, Prague, Warsaw, Sofia, and Buenos Aires; a university mission with 24 professors of lycées and eight professors or lecturers in universities has been established in Rumania.

These establishments have greatly facilitated the interchange of students in various ways. At Prague, for example, the Institute conducted special elementary courses in the French language which enabled lawyers, doctors, engineers, artists, and scientific workers to qualify for French government bursaries. The New York director of the Office National reported in November 1922 that he had placed in the universities, colleges, and schools of the United States as professors of French 115 former bursary holders. During the previous year the number of French bursary holders in American institutions was 62 and the number of American bursary holders in France 60, while 116 students were recruited by the Office for study and travel in France. In 1922 there were 1392 Americans studying at French institutions as compared with 407 at British. The total number of foreign students in French universities that year, excluding vacation courses, was about 6000.

(*To be continued.*)

Looking into Things.

Concerning the Nature of Things. Six Lectures delivered at the Royal Institution. By Sir William Bragg. Pp xi+232+32 plates. (London: G Bell and Sons, Ltd., 1925.) 7*s* 6*d*. net.

TO deal with the "nature of things" as seen by modern physics in a course of six lectures to a juvenile audience is indeed a formidable task, and there are probably few besides Sir William Bragg who could have attempted it with any prospect of success. That success was achieved by the lectures there can be no manner of doubt to any one who had the good fortune to be present. The personal charm of manner of the lecturer and the beauty of his experimental illustrations was a great help, and no doubt many of his audience were carried smoothly along on the stream of his argument, in spite of the fact that the real inwardness of much of it must have been beyond their immediate understanding. The lectures cannot have failed to stimulate a vital curiosity as to the nature of things in some of the young hearers, and may perhaps have laid the foundation of more than one future career to be devoted to the successful deeper delving into that very "nature."

These same lectures, presented in the form of a book, are, however, a much more difficult matter. Cold print has to take the place of the living word, and illustrations, however well done, and descriptions, however clear, can never produce the same effect as actual experiment. To those who have heard the lectures the book must be most welcome as a permanent record in which they can study at greater leisure the facts and ideas put before them. To those reading the book by itself, however, we fear that its contents may prove a little difficult from the "juvenile" point of view. It is, of course, amazing to an older generation how much the more advanced juveniles of to-day are able to assimilate and understand, and possibly to a young mind coming fresh to such a field of ideas there may be less difficulty in following and adopting the writer's line of thought than to an older mind already burdened with many conceptions and some misconceptions. None the less, if one compares the book with the records of similar lectures by Tyndall or Faraday—and it fully deserves such a comparison—it seems to imply a much greater degree of scientific pre-education. To the more mature reader, on the other hand, it offers a delightful presentation of one of the latest developments of physical science in a most agreeable form The scientific investigator who possesses the somewhat rare gift of lucid and attractive exposition owes a duty to the world to use that gift in order to open up the new fields of discovery to a wider circle, and that duty is beautifully performed in this book.

Broadly speaking, the book deals with the atoms and the ways in which they are arranged or grouped in gases, liquids, and solids. The first chapter deals with the structure and size of the atom, full use being made of the knowledge gained from radio-activity and the ionisation-track method of Wilson The author takes care to state that the atom cannot be regarded as a hard sphere and describes its "astronomical" construction; afterwards, however, he follows the path of least resistance and speaks and evidently thinks of atoms in terms of spheres having definite sizes—a fiction which, though convenient, is apt to prove very misleading in detail. In the second chapter the nature of gases is discussed, with the aid of many beautiful experiments and analogies, while the third deals with the nature of liquids.

In the remaining three chapters the author comes to his own proper field of research, dealing with the nature of crystals, beginning with the diamond, studying ice and snow, and ending with the metals. Incidentally, however, many other things are touched upon, among them the simpler aspects of the author's own work on the measurement of organic molecules by means of X-rays, which is undoubtedly one of the

most remarkable achievements of that new weapon of physical research. It is not so very long since we still regarded the atom and the molecule as more or less theoretical conceptions the real size and weight of which could only be guessed at roughly. Here we see not only the dimensions and weights of the atoms accurately known, but also their exact arrangement in well-defined crystals as well as in thin layers of complex organic substances such as fats and waxes The plane diagrams of stereo-chemistry are confirmed and supplemented until we have true three-dimensional models.

Perhaps the only ground for real criticism of Sir William Bragg's book relates to his treatment of the subject of metals and alloys; that particular chapter contains several perhaps minor but unfortunate errors, such as the statement that the addition of nickel to copper does not affect the lattice of copper and does not cause hardening, or that the path of fracture in gold is between the crystals at ordinary temperatures and across them at high temperatures, whereas in reality gold—and all pure metals—normally break across the crystals at all temperatures except within a few degrees of their melting point. A most interesting account is given of the behaviour of crystalline metals under plastic strain, but the reader is left to infer that this was discovered by X-ray methods, whereas it was discovered so long ago as 1899, and there is the further doubt whether it is justifiable to conclude that because X-ray reflections from a thin film of gold show reflections coming from regularly oriented crystals, the film of gold must be entirely or even mainly crystalline. When, however, an author undertakes to deal with "the nature of things" in general, we cannot blame him if he does not prove himself omniscient. The pleasure and profit of the reader—whether juvenile or not—of this book will scarcely be diminished by these things. These readers, and we hope there will be many of them, will share with the scientific world generally a sense of gratitude to Sir William Bragg for having, in this book, done good service in helping to spread the light on "things in general" as physical science now sees them.

British Earthquakes.

A History of British Earthquakes. By Dr. Charles Davison. Pp xviii + 416. (Cambridge: At the University Press, 1924.) 25*s.* net.

FOR thirty-five years past Dr. C. Davison has made the subject of British earthquakes his own; he has written numerous studies of individual shocks and groups of shocks, and has now collected these, with much additional matter, into a volume which will always be of value to those who are interested in the phenomena which used to be called earthquakes, and will continue to be regarded as such by most of us, though the word has acquired a new meaning in modern seismology. By whatever name they may be called, they are a legitimate subject of study, and in this study Great Britain has taken a prominent place, in spite of the limited opportunities of observation; yet these opportunities are not so scanty as is often assumed, for Dr Davison enumerates 1175 distinct shocks, of which he has found record, up to the end of 1912, nor are they by any means all feeble ones; in 1185 the "great church of Lincolne was rent from the top downwards," and in the Colchester earthquake of 1884, 1245 buildings of various kinds were damaged.

If any fault were to be found with the work, it is that the interpretation of the facts is, throughout, presented in terms of one particular theory of origin. This is openly acknowledged by the author at the outset, where he states that the methods of investigation made use of are based on the theory that earthquakes are the result of successive steps in the growth of faults. It is always unfortunate when a worker limits himself to one theory; theories, even the most strongly established, are ephemeral, and when their time is come, they pass away into the limbo of oblivion; or, to vary the metaphor, they are tools which the workman must use, but should always be ready to discard when they are no longer the best adapted for the job in hand. In some instances the facts seem to be as readily, if not more easily, explicable by a very different theory from that adopted by Dr. Davison, yet it must be acknowledged that, if he has allowed the theory to colour his interpretation, he has not let it distort his presentation of the facts, and some of these are curious. It is not commonly known that the first recorded observation of rotation, without overturning, of objects, was made in London itself, where two china figures in a cabinet, in Bloomsbury, facing westwards before the earthquake of March 19, 1750, were found turned round to north-east, after the shock had passed. In 1816 the octagonal spire of the county jail at Inverness was broken through at about five feet from the top, and the upper part twisted round so that the angles of the octagon stood nearly over the middle of the sides below. These are instances of vorticose shocks, first brought into prominent notice by the report on the Calabrian earthquake of 1783, observed in nearly every great earthquake since then, and for long a subject of controversy.

The most noteworthy impression produced by an examination of the book is that British earthquakes are characterised by the magnitude of the area over which the disturbance was sensible As in all earthquake catalogues, there are a large number of shocks which only affected areas of a few miles across,

but of the larger ones, in nearly every case, the extent of the disturbed area is markedly greater than is usual, in countries where earthquakes are frequent. To take the case of shocks which attained a maximum intensity of viii° of the Rossi-Forel scale, Dr. Davison enumerates 8 excluding those of early date and imperfect information; of these, in only one case was the disturbed area distinctly less than 50 miles across; the other 7 affected areas of more than 200 and up to nearly 400 miles in diameter. In the case of Italian earthquakes, attaining the same degree of maximum intensity, barely 1 in 20 would affect an area of 200 miles in diameter, and 9 would be limited to less than 50 miles across, the other 10 reaching limits between 50 and 200 miles. No method has yet been published which, in practice, enables the depth of origin to be determined with certainty, but the difference between Britain and Italy, in the extent of country affected by earthquakes of the same degree of maximum violence, shows that the origins of the British earthquakes are, on the average, markedly more deep-seated than those of the Italian

Many other interesting observations recorded in the volume, which might easily escape notice in a work of its kind, are easy to find, as it is provided with an unusually detailed index. R. D. O.

Psycho-Analysis applied to Children.

Love in Children and its Aberrations: a Book for Parents and Teachers. By Oskar Pfister. Translated from the German by Eden and Cedar Paul. Pp. 576. (London: George Allen and Unwin, Ltd.; New York: Dodd, Mead and Co., 1924.) 24*s*. net.

IN his preface, Pfister, who is a Protestant pastor in Zurich, notes the difficulties inherent in the exposition of the analytical method to the ordinary reader, difficulties caused by the absence of generally accepted data and by the fact that the details of a single analysis would fill a volume. He claims that his vocation and studies have brought to his notice hundreds of mentally tormented persons in whom aberrations of the emotional life in childhood underlay the torment. Yet scientific psychologists have scandalously neglected this important topic, and "when a new and unfamiliar phenomenon like the activity of the unconscious makes its appearance they take to their heels—at least such has been the behaviour of most of the German psychologists."

After a survey of the handling of the problem by philosophers of different epochs, Pfister plunges into a psycho-analytical study of the manifold aspects of love aberrations in children. Freely illustrated by actual examples, this study shows Pfister as able to enter easily into an emotional *rapport* with his subjects, a *rapport* which undoubtedly aids him in obtaining their confidence and co-operation. His accounts of analyses are simply given, and in some cases it is possible clearly to distinguish between the associations of the analysand and the deductions of the analyst—a most important matter for the critical reader. Unless the reader dismisses these accounts as fantastic, they should carry conviction as to the reality of the mental processes concerned in the production of psycho-neurotic symptoms, the variety of which may surprise those unfamiliar with their ramifications: stammering, kleptomania, incontinence of urine, obsessive phantasies, inability to learn a particular subject or to settle down to a career, are a few of the problems that Pfister finds amenable to analytical treatment. Much of the book is devoted to individual cases, which serve to illustrate theoretical principles as they are developed, and the general application of these principles is summed up in the last six chapters, which are easily the most important and most interesting in the book.

Pfister is emphatic in declaring that in every school class there is a notable proportion of children with grave troubles and inhibitions, and that their teachers are in general quite ignorant of how to deal with them. Chapter xxvii contains common-sense advice as to methods of handling such children, short of analysis, which should help teachers or parents who realise the need for help, but one fears that those who most need it will repudiate the need The direct application of psycho-analysis to the individual is considered in the next chapter, where Pfister gives what is certainly one of the best popular accounts of psycho-analysis with its aims, difficulties, and limitations. Like most people familiar with unconscious processes, he realises the futility and even danger of "suggestion" when applied without knowledge, but he admits its applicability in certain instances. He shows how Dubois, the chief exponent of methods of persuasion, uses the emotional relationship of patient and physician as a means of alleviating symptoms even when he claims to work upon the intellectual plane "Auto-suggestion" the author compares with asking a man to lift himself up by his own boot-straps.

There is a tendency to diffuseness and exhortation that may repel some readers, and the translators occasionally betray a lack of acquaintance with English idiom. Perhaps the author goes beyond the popular conception of "love" in making it the basis of the reaction of the individual to his human environment; but many difficulties of the nervous person of any age lie in the inability to come into satisfactory

emotional contact with his fellows, and it is possibly true that the emotion concerned is inseparable from that of love. The book is obviously written by a worker who relies upon his own experience for his deductions; it should be widely read. M. C.

A Mystic Poetess of Ancient Kashmir.

The Word of Lallâ the Prophetess: being the Sayings of Lal Ded or Lal Diddî of Kashmîr (Granny Lal), known also as Lalêshwarî, Lallâ Yôgîshwâri and Lâlîshrî, between 1300 and 1400 A.D. Done into English Verse from the Lallâ-vâkyâni or Lal-Wakhi, and annotated by Sir Richard Carnac Temple Pp. xiv+292. (Cambridge: At the University Press, 1924.) 16*s.* net.

KASHMIR, as the author of this erudite work remarks in his introduction, is the home of wise saws and proverbial sayings; and of the latter none are held in higher repute than the Lallâ-vâkyâni, the "Sayings of Lalla," mainly because those sayings, couched in the form of hymns or lyrics, illustrate the Shaiva Yoga form of the Hindu religion on its popular side, and depict by the medium of metaphor and simile drawn from everyday life the actual hopes and fears of the common folk who nominally followed that system of religion and philosophy. Lalla herself, or Lal Ded as she is commonly called, lived in the fourteenth century of the Christian era, and appears to have spent much of her life in wandering about in a nude state, dancing and singing ecstatically. She was, as her verses indicate, a *yôgini* or female exponent of the Yoga discipline associated with the worship of Shiva, one of the two great gods of neo-Brahmanic Hinduism: but while expressing in her life and poems the utmost devotion to this aspect of the Hindu religion, she was influenced to no small extent, as Sir Richard Temple points out, by the ideas and teaching of the Muhammadan saints of Kashmir, chief among whom was Sayyid 'Alî Hamadânî, leader of the Nakshbandî Order of Sûffis. Though no authentic manuscripts of Lalla's poems now exist, the veteran scholar, Sir George Grierson, has succeeded in collating a tolerably complete text of her verses, which were originally composed in a now obsolete form of Kashmiri and were handed down orally from generation to generation, and it is this text which Sir Richard Temple has translated into English verse.

Apart from the actual songs and their rendering, this book is valuable by reason of the admirable survey of the sources of Lalla's religion and of the theory and doctrine of her faith, which the author has prefixed to his interpretation of her hymns. To those who desire a succinct and illuminating exposition of the growth and nature of the extraordinary medley of magic and metaphysics which we know as Hinduism, Part I. of this work can be confidently recommended, written as it is by one who has steeped himself for fifty years in the history, the antiquities, and the lore of India. Commencing with the Aryan religious instinct, which has a distinctly theistic trend in contrast with the atheistic tendencies of those Asiatic peoples who dwell farther to the East, the author expounds the gradual growth of the Aryan religion and of the old Brahmanic doctrines, which were a blend of "especially developed aboriginal ideas deriving from lands North and West of India with those of aboriginal India itself." He shows how the belief in sacred syllables, *mantras*, and riddles arose, comments lucidly upon the *Upanishads* and the Brahmanic schools of philosophy, and then describes the origin and nature of Buddhism, Jainism, and the Bhâgavat religion, with its great doctrine of *bhakti* or devotion to a personal God, and how the latter joined forces with Brahmanism in its struggle against the atheistic creed of the Buddhist, and so led directly to the identification of the Brahmanic Vishnu with the sole God, Bhagavân. It is observed that Sir Richard Temple dates the death of Buddha "with sufficient certainty" in 488 B.C. There is evidence, no doubt, to support this date; but it is by no means improbable that the date accepted in Ceylon, namely 543 B.C., is correct, particularly as this fits in with the chronology disclosed in the important Hatigumpha inscription of Khâravela, which at quite a recent date has been subjected to close scrutiny by two leading Indian scholars

In one respect the author's estimate of the influence of Alexander's invasion upon India seems also open to comment. He attributes to the Macedonian conqueror "the teaching of state-craft on a large scale and generalship to the Indian Chiefs." Such Hellenistic elements as can be detected in Indian civilisation were certainly due indirectly to the invasion, but Indian polity and the caste-basis of society remained substantially unchanged, and even in military science Indians showed no disposition to learn the lessons taught by Alexander. The kings of India preferred to go on as before, trusting to their elephants and chariots, supported by hosts of inferior infantry. It was not until the sixteenth century that any leader appeared to repeat with success the shock tactics of the Macedonian cavalry. The date of the Kushân king, Kanishka, accepted by Sir Richard Temple, is likewise questionable, and it seems reasonable now to place that king's accession in the early years of the second century A.D. These, however, are minor criticisms and in no way detract from the value of the author's survey of the influences which moulded Lalla's religious belief. His account of the gradual permeation

of Hinduism by the Tantric doctrines and the often revolting worship of the *Shakti* or Female Energy, of the influence of Southern Indian Vaishnavism and of the great Hindu revival associated with the genius of Shankarâchârya, and lastly of Islam upon the minds of Lalla's age, is fully in keeping with the remainder of his careful explanatory essay, and must be read by those who desire to follow the author's detailed exposition of the Trika philosophy, which Lalla conveyed to the public in the guise of popular hymns.

As to the actual translation of the hymns, Sir Richard Temple has wisely refrained from adhering slavishly to the literal rendering of Lalla's words, but has endeavoured to convey her meaning in English metrical form, which, so far as possible, is modelled on the roughness and irregularity of the original. In order that the reader may lack no aid to understanding the inspired words of the prophetess, he has prefixed to each hymn or poem a brief and complete explanation of its inner meaning. Sir Richard Temple's work, which is printed and produced in a style worthy of the Cambridge University Press, is a valuable addition to the growing library of books dealing with the religious literature of India. S. M. EDWARDES.

Our Bookshelf.

Humanism and Technology and other Essays. By Principal C. Grant Robertson, Sir Thomas H. Holland, Prof. C. H. Desch, Sir Henry Fowler, Prof. F. W. Burstall, Prof. W. Cramp. Pp. 91. (London: Oxford University Press, 1924.) 3*s.* 6*d.* net.

THIS is a brilliant little book and as useful as it is brilliant. The title scarcely does it justice, for the book contains essays dealing with the relations of humanism and science generally and a great deal of admirable good sense on education. The occasion of their composition was a vacation school for engineering teachers held in the University of Birmingham and in Oriel College, Oxford, in the summer of 1923. Mr. Grant Robertson, the Principal of the University of Birmingham, fitly leads off with the most general paper and one of the best things in the book, on "Humanism and Science." The note which he strikes is sustained throughout the volume; both sides of education are needed for the adequate training even of the pure technician. If "humanism" means knowledge of the best that has been thought and felt, how can you omit from the best the finest achievements of the scientific intellect? Conversely, students of science who are to make the best use of their training should have at least such contact with the humanities as is implied in an acquaintance with general history, and in particular with the growth of science in relation to the evolution of human society.

Sir Thomas Holland has a humorous epigram on this point, which must not be pressed too far. "It is not," he says, "separate courses of history and science—a mechanical mixture—that are wanted, but the history of science itself, that is, a chemical compound. Giving two separate doses of two unrelated subjects to act as mutual correctives is equivalent to giving a man a metallic sodium pill with a sniff of chlorine gas, when what he wants is merely a pinch of common salt." Sir Thomas Holland lays great and well-deserved stress on the value of biography in historical teaching, and would like to try the experiment of covering a syllabus of chemistry or metallurgy by lectures on biography alone. Prof. Burstall is still more definite. He points out that physical science, as we know it, is a product of the last two hundred years, and its practical applications of the last century and a half. Hence he would have the student consider the historical aspect of the development of engineering since 1775, the starting-point of James Watt's work.

This would no doubt be excellent for the engineering student during his special training; but we should like to put in a plea for the earlier history of science as a part of his general education before he begins to specialise. F. S. M.

The Properties and Uses of Wood. Prepared in the Extension Division of the University of Wisconsin by Arthur Koehler. (University of Wisconsin Extension Texts: Industrial Education Series.) Pp. xiv+354. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

THE author of this book is one of the chief workers in the Forests Products Laboratory at Madison in Wisconsin, which was established by the United States Forest Service in 1910. This laboratory is the largest and best equipped of its kind in the world, and during the fourteen years of its existence has accumulated a large mass of data concerning wood. The work is distributed amongst seven sections—timber mechanics, timber physics, wood preservatives, pulp and paper, derived products (turpentine, tar, charcoal, etc.), industrial investigation, and pathology The results of the researches at Madison have already led in the United States to closer use of timber, to better manufacturing methods, and to prolongation of the life of wood in service. The enormous saving of material due to new methods will, it is believed, postpone the advent of the timber famine, which seemed a few years ago to be so near at hand.

We are fortunate, then, to have this elementary textbook produced at Madison, as it brings to our notice in a handy volume the more important facts about the properties of wood, and shows us how these properties affect the utilisation of timber. The chapters deal consecutively with the sections outlined above; and a detailed notice of the subjects treated is unnecessary. We may, however, signal some points of interest. The great drawback to the use of wood is its tendency to shrink and swell, from which result warping, checking, case-hardening, and honeycombing in timber, as is clearly shown in the third chapter. The practical devices against these defects are seen in aeroplane propellers, where the wood used retains its shape, although it is subjected to the most varying conditions of atmospheric moisture and temperature. The chapters on modern methods of testing timbers are well done. The U.S. Forest Service recommends, after many tests, the classification of each species of wood into four grades, according to the defects they

contain, and assigns definite working stresses for each grade, as shown in Table xv. of this book.

Air seasoning and kiln drying are dealt with in two chapters. The latter process is becoming more and more employed; and when done properly it shortens the time required and turns out a better product than ordinary air drying. We recommend this book to foresters and to all interested in improved methods of utilising timber and eliminating waste.

Ethnographie von Makedonien. Geschichtlich-nationaler, sprachlich-statischer Teil. Mit einem Trachtenbild. Von Prof Dr. Gustav Weigand. Pp. iv + 104. (Leipzig. Brandstetter, 1924.) 3 marks.

PROF WEIGAND is well qualified for his task, and has written an extremely interesting work. He brings out one theory which will be novel to most readers, that the Albanians are not the descendants of the ancient Illyrians, but of the Bessi, a tribe of Thracians referred to by several chroniclers He considers the former a maritime people, whose centre was in the north and west of the Balkans, where they may be traced in the Morlacchi of Zara Cici of Istria, where the Latin speech still lingers on, and Venetians, all of whom are connected with the authors of the Messapian inscriptions of southern Italy. He thus makes Albanian the modern representative of the old Thracian language, which occupied a position intermediate between the Slavonic and Iranian groups He considers that the ancient Thracians became thoroughly Romanised, and, with the exception of the Bessi, forgot their tongue; the fact that Bulgarian, Rumanian, and Albanian, although in no way related, all have a postfixed definite article, unknown in any other Latin or Slavonic tongue, he attributes to the influence of the old Thracian language, and adduces a whole series of analogous occurrences; numerous names of places and of plants are explained as survivors of the old tongue As an example, we may quote Plovdiv as a Bulgarian corruption of the Thracian Pulpidava.

When dealing with the relations between the Bulgarian, Macedonian, and Serbian languages we feel that the learned author has been influenced, in spite of his disclaimers, by his political sympathies. When, for example, on p 73 he gives a list of Macedonian words which he states are *never* used in Serbian, he is certainly influenced by his greater familiarity with Bulgarian · all the words he quotes may be heard commonly in Yugoslavia, even in the north and west.

Electrical Design of Overhead Power Transmission Lines. a Systematic Treatment of Technical and Commercial Factors; with Special Reference to Pressures up to 60,000 Volts, and Distances up to 100 Miles. By William T. Taylor and R E Neale. Pp vii + 266. (London. Chapman and Hall, Ltd., 1924.) 21*s.* net.

THE transmission of electric power in bulk over considerable distances has brought into prominence many almost purely mathematical and physical problems, the solution of which is necessary for economical design. Except in the case of abnormal working, the transmission lines are not traversed by high frequency currents or "surges" of electrical energy It is necessary, however, to know how the resistance and inductance are affected in these cases, and there is a demand, therefore, for mathematical knowledge to simplify and evaluate the requisite formulæ. Considerations of economy also make it necessary to use a very high voltage. But at very high voltages the lines are surrounded with brush discharges which engineers dignify by the name of the "corona" effect. It is essential to know at what pressures these effects begin, and also the power expended in maintaining a corona on transmission lines It is therefore necessary to know the physics of the phenomenon.

The authors have limited the scope of this volume to the consideration of lines up to 100 miles in length and to working pressures not exceeding 60,000 volts. The introduction of hyperbolic trigonometry is therefore rendered unnecessary As power systems in Great Britain are included within these limits, at least at present, this book will prove of use in practice. The authors have wisely adopted international notation, and have laid stress on the standards adopted by the British Engineering Standards Association They give references to practically all the useful literature of the subject

Air Ministry: Meteorological Office British Meteorological and Magnetic Year Book, 1916. Part 5: *Réseau Mondial, 1916. Monthly and Annual Summaries of Pressure, Temperature and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude* (M O No. 227g, Tables) Pp. xiii + 115. (London: H.M Stationery Office, 1924.) 22*s.* 6*d.* net

THESE results are now available for seven consecutive years, 1910–1916, and with the publication of each additional year the data are becoming of increased value for meteorological and physical inquiries. All the information refers to land stations, no data over the sea being as yet directly obtainable. Observations are given for 440 stations, and most of these are under the control of government meteorological services. The results show that the highest mean pressure for the year, at mean sea-level, is 30·19 in. at Barnaoul and Minousinsk in 53°-54° N 83°-93° E., the lowest mean pressure 29·45 in is at S Georgia in 54° S 37° W. The highest mean temperature was 85°·5 F. at Berbera, Somaliland, in 10° N. 45° E., the lowest 10°·6 F. at Markovo-sur-Anadyr in 65° N 171° E The largest rainfall for the year was 486 inches at Cherrapunji in 25° N 92° E., which is 76·3 in. more than the average, followed by 269 inches at Akyab, 77·6 in. more than the average. No rain was measured during the year at Puerto de Arica or at Iquique, at both of which stations the average annual fall is 1 mm. The only rain expected at Puerto de Arica is 0·04 in. on the average in January, and at Iquique 0·04 in. in July. Notes are given for each month on the state of the ice in the Arctic Seas and in the North Atlantic.

Historical Atlas of the British Empire. Pp. 20. (London: Macmillan and Co., Ltd., 1924.) 1*s.*

A USEFUL cheap atlas with thirty-nine black and white maps of the British Empire. Most are only in outline, but a few show orographical features. The text consists solely of a chronological list of events bearing on the history of the British Empire from 55 B.C. to the present day. A great many facts have been crowded into twenty pages, but the maps are the best part of the book.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Hydrography of the *Dana* Expedition.

IT may interest readers of NATURE to know the results of some of the hydrographical investigations carried out by the Danish *Dana* Expedition, under Dr Johs. Schmidt, in the Atlantic in 1921–22

These investigations were begun in the autumn of

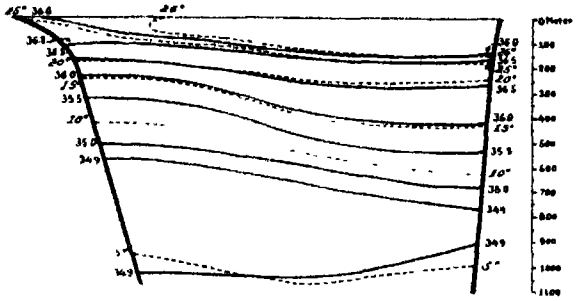


FIG 1 [1]– Vertical section from Cape Yucatan to Cuba The dotted curves are isotherms, and the unbroken curves, isohalines

1921 from the Straits of Gibraltar via Madeira and the Cape Verde Islands to the north-east coast of Brazil, they are of great interest on account of their bearing upon the circulation in the Atlantic

In the eastern part of the Atlantic, outflowing water from the Mediterranean was found as a characteristic stratum with relatively high temperature, and a salinity maximum at about 1000 to 1200 m, so far south as the Cape Verde Islands (see NATURE, January 12, 1922), in the western Atlantic, on the other hand, a colder water layer was found at a depth of 700-1000 m., with a minimum salinity, showing, indeed, values so low as 34·6 per mille, a stratum originating in the southern part of the Atlantic, and then forcing its way up into the western portion of the north Atlantic

The section in question intersects the equatorial

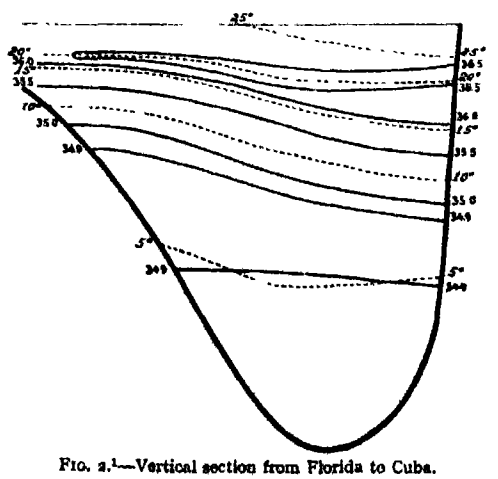


FIG. 2.[1]—Vertical section from Florida to Cuba.

current, which exhibits highly varying salinity at the surface (34-36 per mille); the temperature is high, but decreases rapidly with increasing depth, falling to 10° at a depth of 200-300 m.

[1] All the diagrams are drawn to the same scale.

Part of the equatorial current, with the subjacent south Atlantic water layer, flows into the Caribbean Sea, but the two are here separated by a stratum with high salinity (more than 36·5 per mille) from the Sargasso Sea, which edges in between them at a depth of about 200 m

These three water layers of different origin flow through the Strait of Yucatan into the Gulf of Mexico, but, as is seen from the sections shown in Figs 1, 2, and 3, they turn off at once to the eastward along the north coast of Cuba, continuing between Florida and the Bahama Bank The deflexion due to the earth's rotation causes the isotherms and isohalines to incline to the eastward, the inclination is most pronounced in the Strait of Bemini between Florida and the Bahama Bank, showing that the current reaches its greatest velocity here

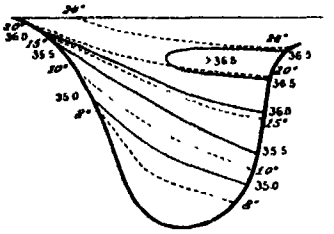


FIG 3 [1]—Vertical section from Florida to Bahama Bank

The south Atlantic substratum can still be discerned in the Strait of Bemini, but soon disappears altogether, whereas the two others, namely, the surface layer from the equatorial current and the salt intermediary layer from the Sargasso Sea, form the Gulf Stream or, more correctly, the Florida Current, which flows north-east along the east coast of the United States outside the coast shoal with a velocity probably varying considerably, like the breadth of the current itself, with the season A value frequently found for the breadth is 60 miles, and the rate of speed may amount to more than three miles an hour

In a section from Norfolk, Va, towards Bermuda (Fig. 4) the Florida current is sharply defined in the spring, but doubtless becomes somewhat effaced in the course of the summer In the waters south of Newfoundland, the Florida Current meets the Labrador Current, giving rise to a mixed product with somewhat lower temperature and salinity than are found in the continuation of the Antille Current which

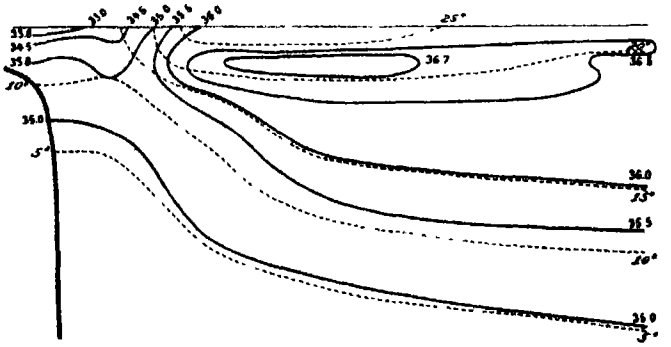


FIG. 4 [1]—Vertical section from Norfolk in a direction towards Bermuda

runs on the right side of the Florida Current and consists of water masses which keep outside the islands of the Antilles

Some of the cold water from the Labrador Current flows on toward the south-west, over the coast shoals, and is gradually warmed, but right to the southern

part of the coast shoal the polar origin of the water is still distinctly perceptible.

The mixed product arising from the Labrador and Florida Currents fills the considerable area of sea south of Iceland, while the warm and salt water washing the coasts of north-west Europe is undoubtedly mainly derived from the Antille Current The term "Gulf Stream" generally employed in European parlance to denote the warm current in the north-eastern part of the Atlantic, must therefore be regarded as inappropriate, since it can only rightly apply to the current off the east coast of the United States, and even this would be better designated by the older name of "Florida Current," as the current in question does not originate in the Gulf of Mexico, but comes from the equatorial region, and covers only the shortest possible distance in the Gulf of Mexico.

A detailed report of the results here summarised will be published in the Journal of the Royal Danish Geographical Society for 1925

J. N. NIELSEN.

Meteorological Institute,
Copenhagen

Absolute Seismometry: a New Method.

THE fundamental problem in all seismometers is to find or devise some observable thing which shall not partake of the earthquake motion Such a thing is spoken of as a steady point, and the work of a seismograph is to record the position of the steady point relative to the neighbouring earth as a function of time. Unfortunately, most mechanical systems under our observation or control require terrestrial connexion through agencies which inevitably transmit forces, so that steady points are subject to acceleration when their connecting links are disturbed. That is to say, the steady point is steady until the arrival of the earthquake and not longer

"If one could only be suspended in space near the earth's surface," Hobbs observes, "but without any attachment to it, the problem of registering the earth's motions would be a simple matter. . . .

"The universal and unsatisfactory substitute for the theoretical unattached observation station outside the earth is the inertia of rest inherent in a suspended mass—the bob of a pendulum . . All pendulums have natural periods of vibration which are dependent on their length, and except in the most improved and elaborate instruments they inevitably combine the motions imparted to them by earth shocks with their inherent natural periods of vibration"

The difficulties are like those which a surveyor would encounter if obliged to survey the shore of a lake with only a row-boat as a place to set his transit. Nevertheless, pendulum seismographs in skilful hands give good results A Mohorovicic states that by exercise of great care the true local earth movements may be known from a seismogram with a mean error so small as 10 per cent. It is still of interest, however, to consider proposals which offer the possibility of an escape from the earth connexion.

It is stated that astronomers have frequently noted the sudden apparent displacement of stars which were under observation at times of earthquake, and that a seismometer utilising this effect has been proposed. Such an instrument would have the advantage of a truly steady point, but, passing over other objections, would have the limitation of sensitiveness only to rotations and not to translations of the earth particle.

The writer has considered using a freely falling body as "steady point" Such an object is not steady in any sense of being stationary, but it is quite detached from local earth features and will not participate in any changes of earth motion that may originate within the period of its fall. It would be better to speak of it as an "independent point."

If a body be allowed to fall from a support which has at the instant of release a horizontal speed V, then after the lapse of time T the body will have departed a distance VT from the vertical containing its point of release. If this departure is recorded by a mechanism which shares the motion of the support, then the recorded departure, X, is given by

$$X = VT - D, \quad . \quad . \quad . \quad (1)$$

where D is the displacement of the recording mechanism during the interval T. Expressing D otherwise, we may write

$$X = VT - \int_0^T V dt. \quad . \quad . \quad . \quad (2)$$

If a continuous succession of falling bodies be observed, X is a known, continuous function of time and equation (2) suffices to determine V completely.

Rather than a succession of discrete bodies a continuous liquid jet may well be employed, as has been done in the experiments to be described. A table free to move in one horizontal direction carried a reservoir from which a liquid ran out vertically in a jet which remained continuous for a length of more than three metres The lower end of the jet passed through a recording device wherein its shadow was cast through a horizontal slit upon vertically moving bromide paper. With the rate of motion of the paper known, the resulting trace gave a complete history of the excursions of the foot of the jet when a disturbance was imposed above.

In order to provide a correct record of the imposed disturbance (limited in this instance to linear horizontal oscillations) a metal pointer was arranged before the slit and mechanically coupled to the moving table so as to reproduce correctly its to-and-fro motions. The shadow of this pointer on the photographic paper left the desired record Appropriate time-signal shadows were also provided.

These experimental conditions differ from those required by equation (2) in that the recording mechanism does not now partake of the motion of the reservoir. The equation of the trace would now be

$$X = s + T\, ds/dt, \quad . \quad . \quad . \quad (3)$$

where s is the displacement of the reservoir orifice at the instant of the release of the particle which is to arrive at the recording mechanism with the horizontal displacement X. For any series of motions of the source of liquid, two curves should appear on the record, related to each other as are X and s in (3). The sample record presented in Fig. 1 confirms this expectation down to the limits of measurement. The broken trace at the top of the figure is a time-signal, being the shadow of a reed which was executing 10·06 complete vibrations per second. The sinuous line next below is the s curve. Next comes another time-signal, marking seconds, with the shadow of the jet at the bottom of the figure. The sequence of events is from left to right. The record covers a period of twenty-four seconds.

A time interval of something less than a second is to be noted between the initiation of the disturbance at the source and its appearance at the foot of the jet This interval is T, the time of fall. The slope of the s curve is, of course, ds/dt. Accordingly, if a line tangent to the s curve at any point be produced toward the right until it shall have progressed from the point of tangency a distance T in the direction of the time axis, the ordinate of its extremity should, according to (3), be X. It may be shown from the figure that such is the case.

It was not thought worth the additional trouble to perform a direct test of equation (2). It will be granted at once that a verification of (3) leaves no room to doubt the validity of (2).

Considered as a possible seismographic method, the device presents several interesting features Two components of motion of a jet are readily registered on one paper through the use of an inclined plane mirror. The apparatus is extremely insensitive to tilts Its response is to velocity rather than to displacement The amplitude of the trace may be increased not only by optional magnification but by obtaining a longer time of fall, thus actually increasing the relative movement of the observed mass and its surroundings As in pendulum instruments, we are dealing here with an inertia seismometer, but it is the inertia of motion rather than of rest which it is now proposed to employ.

When the motion of the source is quite rapid the trace does not obey equation (3), presumably because viscosity prevents the fall from being truly free. Viscosity operates at low speeds too, but without measurable effect on the trace The traces now in hand were made several months ago. It is thought that the liquid used was unnecessarily viscous (some 300 poises) and the jet unnecessarily coarse Further work is in progress.

PAUL KIRKPATRICK

Department of Physics,
University of Hawaii,
Honolulu, Hawaii.



FIG 1

The Positive Electrical Drift in the Air.

IF electrostatic measurements are made in the air on a bridge over the permanent way near any railway station, extraordinarily large positive charges given off by steam locomotives will be observed, especially on starting up. These positive charges are carried by the wind for long distances. Under favourable conditions, that is, when the sky was clear and free from interference from clouds, and a stiff steady wind prevailed, I have noticed strong charges down wind a mile away, from a single engine working in a country siding. Scarcely any effect is noticeable in the opposite direction. Similar results, although on a much smaller scale, are observed near steam-driven road engines. They are not noticeable near petrol-driven or electric traction. These charges are presumably similar to those employed in Sir W. Armstrong's hydroelectric machine.

Under any of the large spans covering the railway termini in London, the potential gradient is zero when they are unoccupied. When locomotives are present high potentials are observed.

On some of the bridges over the Thames very high potentials may be observed according to the direction of the wind with respect to railway traffic. At Blackfriars, for example, very strong positive charges are carried by east winds from trains passing to and from Ludgate Hill and neighbouring stations.

With a westerly wind the Cannon Street traffic affects London Bridge, and that on Hungerford Bridge can be felt on Westminster or Waterloo Bridges, according to circumstances.

Of the two factors concerned in atmospheric potentials, that is, "the forces of Nature" and the activities of man, the latter appears to me to predominate in the majority of the daily readings in and near the metropolis To what extent the former intervene can be deduced only from observations conducted many miles from the drift air from locomotives, steamers, road engines, and doubtless other forms of stationary engines. My own measurements point to the sun as the agent in this case.

The presence of these air-borne charges must necessarily affect the readings at Kew Observatory, surrounded as it is by a dozen stations within a radius of about two miles

Many readers of NATURE will possess copies of the Royal Society's Handbook of the scientific exhibits at Wembley In Dr Chree's admirable article there —a model of popular exposition — curves of the potential gradient at Kew are shown These curves, with their minima during the early hours of the morning, and their maxima at 8-10 A.M and 7-9 P.M, would almost stand for traffic intensity curves The gradient here at Upminster, 17 miles E N E of Charing Cross, when the sky is clear and the wind does not set from the local station, appears to depend principally on London drift air, being very strong with W. to S.W winds and very slight with easterly ones

In any case, the distribution and influence of these positive charges deserves the careful attention of meteorologists During hot weather they appear to be dispersed more rapidly than in cold, for a rising barometer and frost result in unusually high concentrations These drifting positive charges constitute electric currents—in some circumstances these might give rise to compass irregularities Their irregular distribution may conceivably be connected also with certain kinds of "atmospherics" in wireless

WILLIAM C REYNOLDS

"Whartedale," Upminster,
February 11

THE phenomena of electrification in connexion with steam, to which Dr W C Reynolds refers, are described by Mr W A Douglas Rudge in a paper read before the Cambridge Philosophical Society (Proc., vol. 18, p 127), and referred to in NATURE of November 18, 1915 (vol. 96, p 332). The breaking up of water, whether the act of man or of Nature (as in waterfalls), is a powerful source of electrification, but I am unable to accept Dr. Reynolds's suggestion that railway steam may account to any large extent for the early morning minimum and evening maximum of potential gradient recorded at Kew Observatory If this were the case, the change from steam to electric traction in the local trains should have had a profound influence, whereas the daily maximum and minimum

in question seem as marked now as thirty years ago. Richmond station, moreover, is ¾ mile from the Observatory, and is not in the direction from which the prevailing wind blows. It is not a station where much shunting is done A minimum in the morning and a maximum in the evening have been observed at most places, town and country alike.

Dr. Reynolds is, however, I think, quite correct in believing that electrical phenomena in and near large towns are much influenced by the works of man. Steam no doubt may play an important part in some localities, but atmospheric pollution by smoke is, I think, a much more important factor. Reasons for this belief will be found in the Royal Society Handbook to which Dr Reynolds refers.

Undoubtedly a continuous record of potential gradient and other electrical phenomena at some really country place, situated desirably to the south-west of London, is a somewhat urgent desideratum

C CHREE.

Experimental Study of the "Soaring" of Albatrosses.

A SERIES of experiments was made by me in Africa in 1920 in order to study the flight of the vulture Kites were brought into the immediate vicinity of the soaring birds, and carried with them sensitive apparatus, making it possible to find, by means of electrical connexions with registering apparatus on the ground, the variations of internal energy of the air (temperature within 0·02° C., pressure within 0·1 millimetre, speed, direction, and horizontality of wind variations)

The registrations so obtained showed that in all of the observed cases of flight, the birds used ascending air currents, the origin of which was almost always due to temperature variations, the ascending air columns often shifting according to the temperature variations The experiments enabled me to measure (by the relation of the horizontal and vertical speeds of the bird relative to the air) the lift/drag ratio of these birds, which is about eighteen [1]

The soaring of albatrosses and other sea-birds seemed to be quite different. The French Government accordingly sent me on a mission to the South Seas, in the neighbourhood of South Georgia, to study the flight of these birds Registering apparatus was made use of, either on board of the ship or at sea, by means of floaters left from the board (to avoid the possible perturbations due to the boat) The variations of the internal energy of the air were so studied, as in Africa, amongst birds Films taken by an automatic cinematographic apparatus, moved by clockwork, enabled me to find out, by photographic reconstruction, the trajectory of albatrosses and their velocity (The average speed, relatively to the air, was 22 metres)

The experiments showed that the soaring of albatrosses always takes place when there is no ascending current over the waves and the wind is even, but then it is always observed in the air strata where albatrosses fly, that the wind is *increasing according to the altitude*, doubtless it is the friction of the sea on the wind in the low strata that decreases its velocity [2] Albatrosses, then, are continually manœuvring up and down, turning from time to time, going up against the wind and going down with the wind, so that they alternately put themselves in strata of air of different speeds.

I took numerous measurements in the open sea in order to find out experimentally this variation in altitude of the wind speed that albatrosses use. These measures enabled me to calculate the energy gained by albatrosses

The results are as follows:

(1) This sort of soaring is possible only for very swift birds It needs a minimum wind of five metres, close to the water.

(2) The stronger the wind is, the higher (10-15 metres) the birds must do their upper turn

(3) These trajectories of albatrosses are the most advantageous as regards gain of energy

These theoretical conclusions are in agreement with the observations. Albatrosses consequently use the slackening of the wind speed due to friction on the surface of the sea P IDRAC.

L'École Polytechnique, Paris

[1] *C. R. Académie des Sciences*, February 21, July 5, 1920, May 9, 1921, "Études expérimentales sur le vol à voile," par P Idrac Thèse de la Faculté des Sciences de Paris 1921 Vivien éditeur, 48 rue des Écoles, publiée aussi dans *L'Aérophile* (January, February and March 1922)

[2] *C. R. Académie des Sciences*, November 24, 1924, "Le Vol des albatross" Vivien, 48 rue des Écoles *Bulletin de Recherches et Inventions*, March 1, 1925: *Technique Aéronautique*, February 15, 1925

Bio-Chemistry of Muscle Contraction.

THE films of long-chain organic compounds (*e.g.* the aliphatic mono- and dibasic acids) crystallised on glass surfaces possess a structure in which the molecules are orientated so that their terminal groups lie in a series of planes parallel to the surface on which they are deposited This structure is similar to that postulated by Friedel for liquid crystals (*e.g.* soap curds) in the smectic state In the lamellæ between the planes, the long chains are arranged with respect to the surface at an angle which depends on the nature of the terminal group For the mono-basic fatty acids the inclination is about 55° and for the esters of these acids approximately 90°.

Films of aliphatic organic acids when crystallised on glass or on the surface of aqueous alcoholic solutions have been examined by convergent polarised light and found to show the biaxial interference fringes typical of crystal sections in which the acute bisectrix is not normal to the surface. The two optic axes may be accounted for by assuming that successive molecules of acid lie in different directions in space giving rise to a chain of molecules running in a "zig-zag" manner from the surface of the glass. The angle between the chain directions of two adjacent molecules will depend on the configuration of the terminal groups, being different for an acid and its ester and salt.

This type of crystal structure has a possible significance in physiology, for if it be present on the surface of a muscle fibre it would provide a mechanism by which contraction on stimulation could occur

A striated muscle fibre shows alternate isotropic and anisotropic striæ along its length. On contraction, the width of the striæ decreases, the diameter of the fibre increases, and a tension is produced along the axis According to Engelmann, the active constituent in producing the contractibility is the anisotropic part of the muscle. The anisotropy is conceivably due to the presence of orientated molecules, presumably of long-chain amino-acids, which are either present in the membrane of the muscle fibre or are distributed in fibrillæ throughout. Assuming for the moment that the membrane is anisotropic due to the presence of long chains of salts or esters of amino acids, and that these are orientated so as to give a zig-zag arrangement of the molecules in a direction parallel to the axis of the fibre, and further consider the effect of converting these salts into amino-acids. In the first place, the

inclination of successive molecules to one another would be altered just as is the case in the crystalline state when an ester is converted into an acid, and, in the second place, the length of the zig-zag composed of a finite number of molecules would be shortened If the chains of the molecules commence at the interfaces between the isotropic and anisotropic regions, then the chemical change will produce a tension along the length of the fibre

When a contraction wave passes along a muscle fibre the hydrogen ion concentration in the muscle increases, due to the production of lactic acid from glycogen, so that the chemical changes occurring during stimulation are sufficient to account for the conversion of a salt into an acid and of an expanded into a contracted molecular film, and hence for the tension along a muscle fibre W E GARNER

University College,
Gower Street, W C 1

Ether and the Metaphysical Mind.

DR JEANS states in his Kelvin Lecture to the Institution of Electrical Engineers, published as a Supplement to NATURE of March 7, that our own physicists have asked for a machine, while "the more metaphysical minds of the Continent have usually been content to accept action at a distance" He goes on to say "it is something more than a coincidence that Newton, Clerk-Maxwell, Kelvin, and Faraday are all British, while Boscovitch, Einstein, and Weyl are not"

Of the three men chosen as typical of the more metaphysical minds of the Continent, all are mathematicians primarily, while two at least of them are of eastern origin--Slavonic or Jewish These men are therefore representative—if genius is representative of anything—of eastern rather than western Continental thought Two natural philosophies are apparently now available—a natural philosophy based upon essentially British lines of thought as represented by Newton, Clerk-Maxwell, Kelvin and Faraday, and a natural philosophy based upon an eastern philosophical outlook Does this not perhaps account for the difficulty that relativists are finding in getting this new plant of eastern origin to take root in British soil? Dr Merz, in "A Fragment of the Human Mind," pp 18, 24, 25, etc, has pointed out more than once that when an *impasse* is reached in a discussion of some philosophical question, as, for example, in "Hume's dilemma," it is characteristically British to appeal to common sense

We appear to be witnessing not so much the birth of a new theory, for there are already half a dozen or more species of relativity theory — Einstein's, Eddington's, de Sitter's, Weyl's, Silberstein's, Whitehead's, Robb's, and so on—as the birth of a new branch of knowledge—*mathematical metaphysics*

Just as there have always been minds that prefer physics to metaphysics, so there will always be minds that prefer mathematical physics to mathematical metaphysics The former will draw their inspiration, meantime, from the Larmor-Thomson-Lodge School; the latter from the Einstein-Eddington-Jeans School The essential distinction between them appears to be that one demands "a machine," *i.e.*, a mechanical (not necessarily Newtonian) model of the physical universe, built in normal space and time; whereas the other is content with describing it through the medium of a mathematical analogue or map Many of us would be well enough pleased to possess either —the model or the map.

F. F P B.

The Migrations of the Painted Lady Butterfly.

ELSEWHERE in this issue (p 535) is a short account of our present, very incomplete knowledge of the migrations of the Painted Lady butterfly (*Pyrameis cardui*) This article has been written with the sole object of obtaining co-operation in a problem which can only be solved by the combined efforts of a number of observers who know what to look for and are kept interested by knowing what relation their observations bear to the whole question

As is stated in the article, only in Western Europe, North Africa, and Palestine is there any possibility of piecing together the hundred or so known records, and even in this area the conclusions will not be trustworthy until the records are ten times more numerous In the rest of the world, and particularly just to the south of the Palæarctic Desert belt, in Nigeria, Senegal, and the Sudan, for example, every record is of the greatest value, and any one may help to give the clue to the mystery of the origin of the flights which reach the North African coast

May I, therefore, ask any interested person in any part of the world to publish—or to send to me - notes on the seasonal abundance of *Vanessa cardui* in his district, and particularly on any sudden appearances or disappearances of large numbers, and in general any notes or observations relating to the migration of this or any other insect

Records of actual migrations should include the locality, date, species, approximate numbers, sexes (if possible), direction of the flight and of the wind, and any other notes on the meteorological or biological conditions If, in addition, specimens actually caught on migration could be sent to me for examination and dissection, I should be very much obliged

All original notes and observations sent direct to me will be published, as in the past, with full acknowledgments if of sufficient interest

C B WILLIAMS
(Acting Chief Entomologist)

Ministry of Agriculture,
Cairo, Egypt,
January 14

The Spectrum of Potassium excited during its Spontaneous Combination with Chlorine.

THE spectrum of ionised potassium has been studied by many scientists by exciting the vapour with the condensed spark, electrodeless ring discharge, and electronic impacts I have been recently studying the spectrum emitted by potassium burning in chlorine at normal pressure *spontaneously*, and have obtained the following interesting results

The photographs taken with the quartz spectrograph show a very strong emission band in the red extending from about 7200 to 6150, corresponding to the emission and absorption bands obtained by McLennan and Ainslie in the fluorescence and absorption spectra respectively of dense potassium vapour Besides this, many arc lines of moderate intensity and the following *enhanced lines* are seen

4466, 4388, 4307, 4220 and 4115

As the slit was kept fairly broad, some of the wavelengths given are the mean values for lines very close to each other

These results show that the *electron affinity* of the chlorine atom, together with the temperature attained by the potassium vapour as a result of the chemical reaction, must account for the excitation of the *enhanced lines* in the absence of any external electrical forces I am following up the work in connexion with the remaining alkali metals A

detailed account of the results obtained hitherto, along with an explanation of the processes involved in the emission of the enhanced spectrum, will be published shortly L. A. RAMDAS.

210 Bow-Bazar Street,
Calcutta, India,
February 19

Heterogeneous Catalysis.

IN connexion with prevailing notions on heterogeneous catalysis, the following remarks of Graham, written in 1868 (Proc. Roy. Soc., 16, 422, 1868; "Chemical and Physical Researches," 1876, p. 286), would seem to be of interest. Referring to the adsorption of hydrogen by platinum, he says: "The hydrogen appears to be polarised, and to have its attraction for oxygen greatly heightened. I beg to offer the following representation of this phenomenon, with an apology for the purely speculative character of the explanation. The gaseous molecule of hydrogen being assumed to be an association of two atoms, a hydride of hydrogen, it would follow that it is the attraction of platinum for the negative or chlorylous atom of the hydrogen molecule which attaches the latter to the metal. The tendency, imperfectly satisfied, is to the formation of a hydride of platinum. The hydrogen molecule is accordingly polarised, *orienté*, with its positive or basylous side turned outwards, and having its affinity for oxygen greatly enlivened. It is true that the two atoms of a molecule of hydrogen are considered to be inseparable, but this may not be inconsistent with the replacement of such hydrogen atoms as are withdrawn, on combining with oxygen, by other hydrogen atoms from the adjoining molecules. It is only necessary to suppose that a pair of contiguous hydrogen molecules act together upon a single molecule of the external oxygen. They would form water, and still leave a pair of atoms, or a single molecule of hydrogen, attached to the platinum." (The formula of water is evidently considered to be HO.)

J. R. PARTINGTON.

East London College,
University of London

Influence of Radiation on Ionisation Equilibrium.

IN a recent letter (NATURE, March 14, p. 377) Saha and Swe develop the theory of the stationary state of a medium traversed by radiation of a temperature different from that belonging to the medium. Their argument seems to follow thermodynamic lines, supposing this to be the case, it may be of interest to point out how the same results may be obtained starting from Einstein's classical paper on Planck's radiation law (*Phys. Zeit.*, 18, p. 121, 1917) and from Milne's extension to the photo-electric effect (*Phil. Mag.*, 47, p. 209). The principle of this alternative method, already well known (Milne in this way recently has derived a formula equivalent to formula (3) of Saha and Swe, in his investigation of the equilibrium of a Ca^+ chromosphere, Mon. Not. R.A.S. 85, p. 119), consists in formulating the conditions required for a stationary state by means of probability laws governing the elementary processes involved. These probability laws themselves have been derived from the consideration that in thermodynamic equilibrium the number of elementary processes in one direction ought to balance the number occurring in the opposite direction.

For example, consider a gas traversed by radiation of a different temperature. Milne's results allow us to compute the ratio of the number of photo-electric ionisations to the number of electron-captures accompanied by emission of radiation, in terms of the relative concentration of neutral and ionised atoms. Requiring this ratio to be equal to unity furnishes a value for the degree of ionisation identical with formula (4) of Saha and Swe.

J. WOLTJER, JR.

Observatory, Leyden,
March 23.

Bushmen Rock Figures.

THE comparisons made by Prof. Dart (NATURE, March 21, p. 425) between Bushman paintings and Asiatic figures will need much wider knowledge than we at present have on our side. The turn-over cap called "Phrygian" belonged to Phœnicians of Tyre and Sidon, and to men of Dabig between the Euphrates and Gulf of Alexandretta (see "Gates of Balawat"). It is seen about the Mediterranean now, and is much like the cap of the London draymen fifty years ago. The cap with the long tail is not only Babylonian, but is the typical head-dress of the Hittite and Syrian god Sutekh. Both of these forms may have a much wider spread, and the Bushman might have been figuring a liripipe hood of five centuries ago.

The Figure 13, quoted as Egyptian, is a man of Punt. The "figurino of an Egyptian courtier of the period of Thothmes III" I have handled. It is a well-known kind of moulded pottery figure, from Thebes, but more probably modern than ancient. There is, no doubt, a wide basis of African custom and culture below Egyptian civilisation, of which I have quoted dozens of examples, in *Ancient Egypt*, 1914, pp. 115, 159, and the indications are that these are due to a common basis, and not to importation from Egypt. General likenesses to Egyptian figures do not strike those who know them best, the women of Fig. 12 might be Somalis, but not Egyptians. Resemblances of names require an exhaustive inquiry as to possible meanings and origins among all the languages that may have intervened, before they can be accepted with caution. A name always means something, it is not a casual sound.

FLINDERS PETRIE.

5 Cannon Place,
Hampstead, N.W.3.

On the Resonance Radiation from Thallium Vapour.

RECENTLY we have shown that the absorption spectrum of non-luminous thallium vapour exhibits lines corresponding to the sharp and the diffuse series, and that $1\pi_2$ is the ground orbit of the valence electron in the atom of this element. A further confirmation of this view is given by our latest experiments on resonance radiation. In these experiments the radiation emitted from the vapour in a lateral direction was examined when the vapour was illuminated with light obtained by using different colour-screens. It has been found that the vapour, subjected to radiation $\lambda 5350$ ($1\pi_1 - 1\sigma$), does not emit any radiation, while when illuminated by radiation $\lambda 3775$ ($1\pi_2 - 1\sigma$) it acquires the ability of emitting radiations $\lambda\lambda 5350$ and 3775, the fluorescent track in this latter case being of a beautiful green colour. These experiments, together with the experiments on absorption, strikingly confirm that $1\pi_2$ is the normal state of the atom. Further experiments in this direction are in progress.

A. L. NARAYAN.
K. RANGADHAMA RAO.

Research Laboratories,
Vizianagram.

The Migrations of the Painted Lady Butterfly.

By C. B. WILLIAMS, Acting Chief Entomologist, Ministry of Agriculture, Egypt.

THE migrations of birds have been known for centuries, and have, particularly in recent years, been moderately well studied and understood. The migrations of fishes are also generally known, and within the last few years the remarkable journeys of the eel have been definitely determined. Most people know that locusts make huge migratory flights, invading countries in countless numbers and doing incalculable damage; but it is surprising how few are aware that such frail insects as butterflies make extended migratory flights, often in enormous numbers and over hundreds and even thousands of miles

Scattered throughout literature there are references to nearly two hundred species of butterflies which have been seen in migratory flights. In most of these there

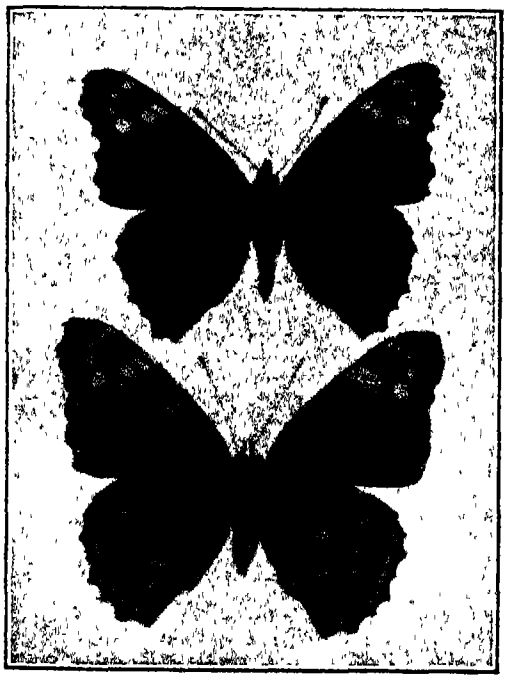


FIG. 1.—The Painted Lady or Thistle butterfly (*Pyrameis cardui*).

are unfortunately only one or two records for each species, and in only a very few cases do the records number more than a dozen. In two or three, however, we have sufficient evidence to get a general idea of the movement, and of these the most complete is that of the Painted Lady or Thistle butterfly, *Pyrameis cardui* (Fig. 1).

This butterfly, like many migrants, has a very wide range and is indeed known from every continent, and may be seen from the equatorial tropics to within a few degrees of the arctic circle. In Northern and Central Europe it is sometimes common, sometimes rare, and sometimes a summer will pass without a single specimen being seen. In England it is usually first seen at the end of May or beginning of June, and becomes again more common in August and September, but there is no evidence of an individual surviving the winter in any stage. The same seems to be true of all Europe north of a line through the middle of France and South Germany or Switzerland.

Observation has shown that north of this line the country is dependent for its Painted Lady butterflies entirely on migrations from the south. In the late spring, isolated individuals or huge swarms of this butterfly set their faces more or less to the north or north-west and, in Western Europe, cross France and England, and in some years may reach so far as Iceland. Farther east, similar migrating bands may fly from Italy or the Balkan peninsula, and cross Switzerland, Austria, Czecho-Slovakia, and Germany, and invade Scandinavia. Still farther east, in Russia, it is probable that the same movement occurs, but the records are few and far between.

Studying the movement in the south of Europe, we find that the majority of the migrating insects do not originate here, but cross the Mediterranean from North Africa, apparently finding but little difficulty in the long sea passage. Still more recently, evidence has been accumulating that even the north coast of Africa and Palestine do not represent the origin of the insect, and it appears that they reach the coastal regions of Africa from the south They have been recorded entering Algeria from the south; they have been seen crossing the Nile Valley near Cairo in thousands, coming from the south-eastern desert; they have been recorded as entering Palestine from the east in countless numbers for days on end, and finally comes a record of the same butterfly flying towards the west in Mesopotamia. They have been seen massed in great numbers, apparently resting during migration, in the Egyptian Desert near the Sudan border; but south of the desert belt, there is no record except a doubtful hint from Nigeria.

The present state of our knowledge of their movements in Europe, North Africa, and Asia Minor can therefore be summarised as follows (see also Fig. 2).

From somewhere in, or south of, or south-east of the long line of desert stretching across North Africa and Asia Minor, the butterflies begin their north and north-westerly movement in the early spring and arrive at the southern shores of the Mediterranean usually about April. From Palestine they appear to fly through Syria and Turkey to the Balkan States, and from Egypt, Tripoli, and Algeria they cross the Mediterranean, arriving in southern Europe usually early in May. They pass on, probably leaving behind stragglers all the time, and arrive on the level of the southern shores of England at the end of May or beginning of June, reach the northern part of Scotland about the middle of June, and have been recorded in Iceland in July.

The dates given are those of the first main drift, but the movement appears to continue for many weeks or even months at irregular intervals. Thus the butterflies have been seen crossing the Mediterranean north of Egypt so late as July, and in some years they appear to reach England from the Continent so late as September. These presumably are the progeny of later broods than the first movement. Apparently there is a general tendency for all butterflies over the whole

area to drift to the north-west during a large part of the year.

In other parts of the world there are also migrations, but the records are at present too few to be capable of discussion. They fly into California from the south in the spring at irregular intervals and have also been seen migrating in Florida. It is, however, only in Europe, North Africa, and Asia Minor that we can bind together the evidence into the semblance of a whole It is curious to note that in Ceylon, where migrations of many species of butterflies occur on a very large scale, one observer notes that *P. cardui*, although not uncommon, has not been noticed as entering into any of the flights.

As the migrations of birds are better understood than those of any other animal, it will be interesting to draw

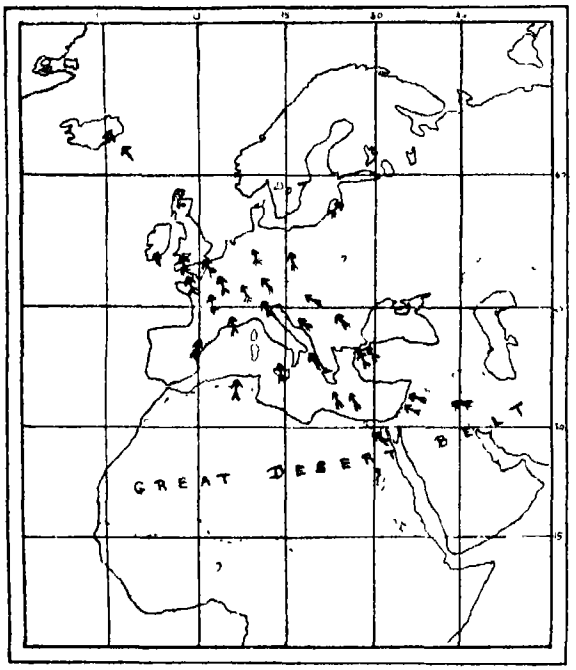


FIG. 2.—Sketch map indicating the known migrations of the Painted Lady butterfly

a comparison and see to what extent the migrations of the Painted Lady butterfly resemble them

In the first place, we have the remarkable fact that in the butterfly there is practically no evidence of any return from north to south in the autumn. So far as we can see, all those butterflies which fly to the north of the area in which they can breed throughout the year are lost completely to the species, as either they or their offspring perish during the winter The butterfly does not seem to have developed the ability to hibernate in any stage; unless it can breed continuously it cannot survive. The statement seems so remarkable that some investigators believe that there is a return flight, but that it is performed individually and not in mass, and so escapes notice. While this may be so, it is at present unsupported by any direct evidence and must be classed as an hypothesis, as opposed to the known facts of the northward movement in the spring. One cannot help referring here to the remarkable contrast which is found in the case of the Monarch butterfly (*Anosia plexippus*) in North America. Here the southward autumn flight is known from dozens of observations, while the direct evidence for the northward flight in the spring is extremely scanty, although from the complete absence of any record of hibernation in the Northern United States and Canada, we presume that such a return flight must occur.

The possibility must also not be overlooked that considerable flights may take place at night. This may seem to be a rather unexpected statement to be applied to butterflies, but it is actually supported by direct observation and capture of Painted Lady butterflies at night at light-ships and on boats at sea The same butterflies have also been seen flying to the north off the coast of Egypt between three and four in the afternoon, and to reach land in this direction they must fly all night or rest on the sea

In the case of the Painted Lady, it follows that even if there is a return flight, it is in a later generation. No individual butterfly ever performs the same journey twice, even in opposite directions, thus differing from most birds, which make the journey twice a year for several years This eliminates any possibility of memory being a factor in the determination of the route.

The next difference between the migration of the butterfly and most birds is that it is only a part of the butterfly population which migrates, while many stay behind to continue breeding in the countries where they hatched out If it is really true that there is no return flight, this of course would be absolutely necessary, as otherwise the species would gradually move northwards and become exterminated

Next we have the fact that while the migrants which reach England, for example, lay eggs and produce offspring there, those that have stayed behind in South Europe or North Africa are also breeding. In contrast to what is usually found in birds, breeding takes place throughout the whole range of the migration.

This raises the question as to whether it is the same individuals that perform the whole flight from Africa or Mesopotamia to Northern Europe, or whether the first migrants stop to lay eggs on the way and their offspring continue the flight later. The evidence at present indicates that the same individuals can, and in favourable years probably do, complete the whole flight, but that their progeny may also form a later migration, starting from where the eggs were laid by the original migrants, or may continue the migration alone if for any reason that of the previous generation has been brought to an end.

This in turn raises another question How is it that the butterflies have time to perform their long journeys, and, having hatched from a pupa in Africa, can wait to lay their eggs in England? The answer to this is still obscure, except that we know that *P. cardui* usually hatches out from the chrysalis with the generative organs completely undeveloped, but with a very large reserve fat-body. Apparently the migration generally takes place before the genital organs are functional (thus resembling the locusts); but this is not an absolute rule, as butterflies have been known to lay eggs while apparently on migration. When we know what determines the original development of the fat-body at the expense of the ovaries, and what later circumstances cause the ovaries to develop at the

expense of the fat-body, we shall be nearer the solution of one of the problems of migration.

Finally, as the life of the butterfly is not dependent on migration, we get another important difference from birds in the great irregularity of the occurrence and extent of the movement. Sometimes, as in 1879, Western Europe is invaded by countless millions, while in other years the migration is at a minimum and scarcely a single individual reaches the British shores. This irregularity of flight is probably an indication of varying conditions in the countries of origin of the swarms, but as we are not yet certain where these are or if they are always the same, it is idle to speculate as to what are the conditions that determine the start of the flight. Once the migration is in progress, what little evidence we have indicates that the direction is influenced, but not entirely determined, by the wind. The butterflies have a tendency to fly into the wind rather than with it, and there are one or two records, from localities with a daily change in wind direction due to land and sea breeze, of a corresponding daily change in the direction of the flight

This tendency to fly more or less into the wind would of itself partly account for the general trend of the migration to the north and north-west, as in the spring there are prevalent northerly winds over Southern Europe, the Mediterranean, and North Africa (see Fig. 3). However, one feels that this alone is not the explanation of the main trend of the flight, and further study and many more records are necessary before it will be possible even to guess at the real cause

We are similarly in ignorance as to what are the conditions which cause the insects to cease migrating—if it is fatigue, low temperature, food, or the development of the sex organs and sex instinct, and if the latter, the problem is only put one stage further back to what is the cause of this change.

The final question, which is with so many the first to be asked, is. Why do the insects migrate?



FIG. 3.—Prevailing winds in Europe and North Africa From Kendrew's "Climate of the Continents"

This is best perhaps at present left entirely alone. Whether, as some hold, a habit is explained when some advantage has been shown to accrue from it to the species, or whether, as I insist, there must be an immediate mechanistic cause for the migration of each individual, is a question the discussion of which would be out of place in the present article.

Further Evidence regarding the Correlation between Solar Activity and Atmospheric Electricity.[1]

By Dr. LOUIS A BAUER,
Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D C, U S A.

THE geophysical element which has thus far shown the most marked correlation between manifestations of solar activity, as, for example, sunspottedness and prominences, is some measure of activity of the earth's magnetism. The range of the magnetic diurnal variation, as shown by observations extending over nearly a century, is known to pass through a definite fluctuation to the extent of 50 per cent., or more, during a sunspot cycle. The synchronism between the solar curve and the magnetic curve is not exact, however, the times of maxima of the two curves differing not infrequently by one year or more. Thus, at the Kew Observatory the absolute daily range of the magnetic declination during the period 1858–1900, or approximately 4 sunspot cycles, passed through a maximum value, three times out of the four cases, one year *in advance* of the sunspot maximum. During the recent sunspot cycle (1913–1923) the maximum magnetic activity showed a lag of two years with reference to the solar curve. In 1893, when sunspottedness was a maximum, the earth's magnetic activity, after having been increasing for several years previous, was quite markedly lessened, and then rose to a maximum value in 1894

Attention may also be directed to the fact that no index of the sun's activity, as given thus far by solar observations, is apparently a complete measure of the radiations or emanations which are responsible for the magnetic phenomena just described. Nor do the solar measures in themselves, or for that matter the magnetic measures, give us a definite indication of the *sign* of the electrically charged particles which may be shot out by the sun during periods of intense activity.

The desirability is thus seen of finding some other geophysical element which may be affected in such a manner by solar changes as to supplement effectively the knowledge gained from magnetic effects and polar lights. That element may be atmospheric electricity; some results concerning the correlation of this element with solar activity were presented before these societies [2] a year ago. The present communication is based on atmospheric-electric data accumulated during the past 7 sunspot cycles. Manifestly, it will not be possible here to attempt more than a summary of the entire

[1] Presented before the joint meeting of the American Physical Society, the American Astronomical Society, and Sections B (Physics) and D (Astronomy) of the American Association for the Advancement of Science, Washington, D.C., December 30, 1924.

[2] See footnote 1.

investigation; those interested may be referred to the fuller publication.[3] Since atmospheric electricity is so continuously subject to much greater fluctuations of all kinds, natural and artificial, it will be appreciated that the tracing of a definite connexion with solar activity is much more difficult than in terrestrial magnetism, and, accordingly, an allowance must be made in the critical examination of the results. *So far as possible, only data derived from so-called electrically undisturbed days*, i.e. *days of no negative potential and no pronounced disturbances, have been utilised.*

ATMOSPHERIC POTENTIAL GRADIENT AND VARIATIONS.

In Table I., s represents the percentage change in the atmospheric element corresponding to a change of 1 in the Wolf-Wolfer observed sunspot numbers, and S_m the mean sunspottedness of a complete cycle beginning with the year of minimum.

Table I. summarises the average values of s, expressed in percentages of the respective electric quantity, for each of the 7 sunspot cycles beginning with 1843, derived from the observed values of the potential gradient, P, and some measure of its diurnal and annual variations.[4] The stations for which sufficiently long series are at present available for the various cycles are as follows: Brussels for Nos 1, 2, and 3; St. Louis, Missouri, for portions of Nos 2 and 3; Greenwich for No. 4; Perpignan, Lyons, Kew, and Greenwich for No. 5; Kew, Greenwich, Perpignan, and Kremsmünster for No. 6, and Ebro (Spain), Eskdalemuir, and Kew for No. 7. An attempt has been made in the last column to give some idea of the weight, w, to be attached to the tabulated s, according to the character of the available observations and number of stations utilised. Nos. 1 and 4 get the lowest weight (0·5), as they each depend on one station alone, no trustworthy observations at other stations for the corresponding period being at present available. No. 7, on the other hand, is given the largest weight (3), as it depends upon the most modern observations at three distant observatories; No. 6 ranks next in reliability. Though No. 5 depends on the data from several observatories, it is given a weight of but 1·5, as during the period covered the observations are all relative ones, the method of reduction to infinite plane not having as yet been introduced.

TABLE I.—VALUES OF SUNSPOT COEFFICIENT, s, FOR ATMOSPHERIC ELECTRICITY, 1843–1893

No.	Sunspot Cycle.	S_m	s (per Cent.)	w.
1	1843–1855	53·7	−0·70	0·5
2	1856–1866	49·6	+0·53	1·0
3	1867–1877	56·6	+0·22	1·0
4	1878–1888	34·6	+0·09	0·5
5	1889–1900	38·8	−0·24	1·5
6	1901–1912	31·1	+0·49	2·5
7	1913–1923	40·6	+0·24	3·0
Mean, Nos. 2, 3, 4, 6, 7			+0·34	8·0
Mean, Nos. 1 and 5			−0·35	2·0

It will be observed that for five of the seven cycles the sign of s is plus, which means that increasing potential gradient and diurnal and annual ranges corresponded with increasing sunspottedness, the average value of s being +0·34. For two of the seven cycles, namely, Nos. 1 and 5, the sign of s is negative, implying that increased potential gradient and ranges corresponded with decreasing sunspottedness, the average value of s being −0·35.

He who wishes to regard the two cases (Nos. 1 and 5) as contradictions of a definite correlation between atmospheric electricity and solar activity, may take the algebraic weighted mean of all values of s for the 7 cycles and obtain +0·20, which corresponds approximately to the value for the period (No. 7) of most trustworthy observations. However, I am inclined to advise leaving open the possibility of a reversed relationship, especially as the indications afforded by No. 5 are of a character not lightly to be dismissed. For example, the most striking part of the reversal occurred during the year 1893, when, as has already been remarked, there was also a notable depression in the earth's magnetic activity, in spite of its being the year of sunspot maximum,[5] this is the first definite correlation between disturbances in atmospheric electricity and terrestrial magnetism.

Comparing the values of s for the past two sunspot cycles, it will be observed from Table I. that, while they are both plus, the value for the cycle (No. 7) of more intense solar activity, as indicated by the mean sunspottedness, S_m, was only about one-half of that for the preceding cycle (No. 6). The same fact is found to apply to the values of s derived from two different measures of the earth's magnetic activity obtained independently by Dr. Bartels, of the Potsdam Observatory, and myself. The ratio of s (No. 6 : No. 7) is 2·0 for atmospheric electricity and 1·7 for terrestrial magnetism.[6] Even the variation during the year of s follows essentially the same law for both geophysical phenomena. Thus the ratio of s (October to March : April to September), for the period 1911–1921, was found to be 2·4 for atmospheric electricity and 1·7 for terrestrial magnetism. If a definite correlation is to be ascribed between solar activity and terrestrial magnetism, the facts just cited point to the conclusion that there is likewise a definite correlation between solar activity and atmospheric electricity.

Fig. 1 shows the high degree of correlation between solar activity and atmospheric potential gradient and its diurnal and annual ranges for the two sunspot cycles, 1901–1923, during which the atmospheric-electric data are of highest reliability. For the first cycle (1901–1912) we have available electric data at Kew, Greenwich, and Perpignan (France). For the second cycle (1913–1923) the data were obtained from the observatories at Kew, Eskdalemuir (Scotland), and Ebro (Spain). I desire here to acknowledge my indebtedness for latest data at these observatories to the very cordial co-operation in this research given by the respective directors.

While in the fuller publication the data from each observatory have been treated independently and

[3] *Terr. Mag. and Atmos. Elec.*, vol. 29 (1924), pp. 23-32 and 161-186.

[4] Table I. was derived from the values of s given *in extenso* in the author's Table 7, p. 171, *Terr. Mag.*, vol. 29, p. 171.

[5] See Fig. 2, *Terr. Mag.*, vol. 29, p. 31.

[6] While s for cycle No. 7 was only about one-half of that for No. 6, the total electrical output during each cycle may have been about the same. Thus if R is the range or difference in sunspot number between minimum and maximum, then we have for No. 7, $Rs = 102 \times 0{\cdot}24 = 24$, and for No. 6, $Rs = 61 \times 0{\cdot}49 = 30$.

without the use of any smoothing process, it was thought desirable in the graphs, Nos. 3, 4, and 5 of Fig. 1, to group them together as indicated and take smoothed means according to the well-known formula $(a+2b+c)/4$. With the aid of overlapping data for about two years, a preliminary attempt was made to refer the mean results for the two cycles to the same base line; a more accurate reduction will be possible later. Curve 5 is a combination of the results shown

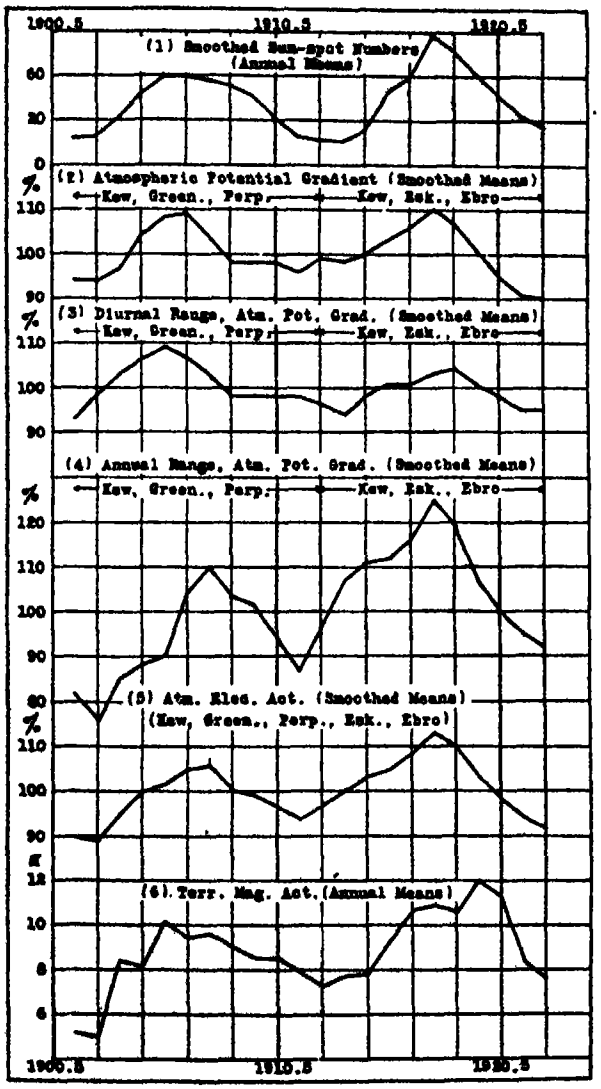


FIG. 1.—Showing degree of correlation between solar activity, atmospheric electricity, and terrestrial magnetism for the two sunspot cycles 1902–1923. (Dependent on atmospheric-electric data at Kew, Greenwich, Perpignan, Eskdalemuir, and Ebro, and on magnetic data at Potsdam, 1900–1905, and at Cheltenham, Maryland, 1905–1923.)

separately in Curves 2, 3, and 4. The smoothed sunspot numbers are those of Wolf and Wolfer with extensions according to latest data kindly supplied to me by Dr. Wolfer. Curve No. 6 of the measure of the earth's magnetic activity (ϵHR) has been derived by me with the aid of the absolute diurnal ranges (R) of the horizontal intensity (H) at the Potsdam Magnetic Observatory, 1900–1905, and at the Cheltenham Magnetic Observatory, Maryland, from 1905–1923; the data at the two observatories were reduced to the same basis and expressed in terms of the unit ϵ. For the most recent values of R at the Cheltenham Observatory, I am indebted to the Director of the United States Coast and Geodetic Survey. In the case of Curve No. 6 no smoothing was attempted, in order to obtain some idea how satisfactorily a measure of terrestrial magnetic activity might be obtained from one observatory alone, in view of the smaller effect of local disturbing influences in terrestrial magnetism than is the case for atmospheric electricity; however, since the atmospheric-electric data pertain to the electrically undisturbed days, only the magnetic ranges from the ten least disturbed days per month were used.

From Fig. 1 *the following conclusions may be drawn for the period 1901–1923*: (*a*) The atmospheric potential gradient and its diurnal and annual ranges show a high degree of correlation with the sunspot curve, increasing atmospheric-electric quantity in each case corresponding with increasing sunspottedness for both cycles; (*b*) the combined measure of activity as obtained from observations of the atmospheric potential gradient and its diurnal and annual variations at several stations may show as high a degree of correlation with sunspottedness as measures of terrestrial magnetic activity; (*c*) the annual means of the atmospheric potential gradient, of its diurnal range, and of its annual range follow closely parallel courses from year to year. (Conclusion (*c*) has been found to hold generally for the various cycles investigated.)

Table II will give some idea of the general agreement in the values of s, as derived separately from the observed values of the potential gradient, the diurnal variations, and annual variation at the three observatories. Eskdalemuir, Kew, and Ebro, for the region from Scotland to Spain and for the period of most trustworthy data, 1911–1921. The values of the correlation coefficient, r, are also given for each observatory; it will be seen that, for the potential gradient, r varies from 0·76 to 0·95, according to the location of the observatory, the mean value being 0·85. The mean value of r is lowest for the annual variation, as this quantity cannot be determined entirely satisfactorily from single years of observation. The mean value of s, it will be seen, is practically the same for each atmospheric-electric quantity.

TABLE II.—COMPARISON OF VALUES OF SUNSPOT COEFFICIENT, s, FOR VARIOUS STATIONS AND ATMOSPHERIC-ELECTRIC QUANTITIES, 1911–1921 (s is expressed in Percentages of Mean Values of Atmospheric-Electric Quantity.)

No.	Observatory.	Pot. Grad.		Diur. Var'n.		Ann. Var'n	
		s	r	s	r	s	r
1	Eskdalemuir .	+0·19	0·85	+0 20	0·53	+0 44	0·65
2	Kew. . .	+0 20	0 76	+0·17	0 58	+0·19	0·30
3	Ebro . .	+0 31	0·95	+0 33	0·78	+0·23	0 32
4	Means .	+0 23	0·85	+0 23	0 63	+0 29	0·42

VERTICAL CONDUCTION CURRENT AND ELECTRIC CONDUCTIVITY.

According to observations at Kew (1911–1921) and Ebro (1914–1923), the vertical conduction current of atmospheric electricity during the past sunspot cycle apparently increased with increasing sunspottedness,

at the average rate of 0·32 per cent. for a change of 1 in the sunspot number. As this is about the same average rate of change shown by the potential-gradient observations at the same two observatories, the present indications are that the average rate of change for several stations of the atmospheric-electric conductivity with sunspottedness, if not zero, is small. The continuous observations of negative electric conductivity at the Potsdam Observatory likewise indicate but little change with changing solar activity. (Since this paper was prepared it has been found, by a method[7] which minimises the effect of uncontrolled changes in the factor to reduce potential gradients to volts per metre over level ground, that the average value of s for the Potsdam observations from 1913–1923 was +0·27 per cent. of the mean value of the potential gradient, *i.e.* the potential gradient increased, on the average, with increasing sunspot activity Accordingly, the vertical conduction current at Potsdam also increased during 1913–1923 at the average rate of about 0 27 per cent for an increase of 1 in the sunspot number)

Atmospheric Electricity and Terrestrial Magnetism.

The foregoing results indicate a close correspondence between such changes in atmospheric electricity and terrestrial magnetism as may be dependent upon the state of the sun's activity from cycle to cycle However, the close correspondence between the two different geophysical phenomena also holds in other respects For example, the so-called "earth-effect" on sunspottedness during circumminimum years, the diurnal range of the atmospheric potential gradient, the diurnal range of the potential gradient of earth currents, the aurora borealis frequency for latitudes 51° to 58° north, and terrestrial magnetic activity all pass through a double periodicity during the year, the maxima and minima occur near the equinoctial and solstitial months respectively. Furthermore, the retardation of the second maximum from September to October is common to all phenomena For further explanation, reference must be made to the fuller publication.[8]

It would appear that terrestrial magnetism and fine weather atmospheric electricity are more closely associated than has heretofore been thought to be the case. Besides being subject to diurnal change, they both show similar fluctuations from year to year and from month to month. Whether atmospheric electricity, like terrestrial magnetism, is subject to a still longer cycle of changes than that of the sunspot cycle, seems not unlikely, and is the subject of further inquiry.

In a notable respect the changes of atmospheric electricity differ from those of terrestrial magnetism, namely, as regards relative magnitude. The periodic variations of the earth's magnetic elements are usually but fractions of 1 per cent. of the respective element, whereas in atmospheric electricity the diurnal and annual ranges, even for undisturbed conditions, may be of the same order of magnitude as the normal potential gradient itself. If such large percentage changes as 100, for example, are likely to occur in the potential gradient during the day and the year, it should not be surprising if there is, on the average, a 30 per cent. change between the years of minimum and maximum sunspottedness.

Is the Sunspot Influence Direct or Indirect?

While it may appear reasonable that atmospheric electricity does vary with solar activity, it is not possible to decide from *a priori* considerations whether the potential gradient ought to be high or low for maximum sunspottedness, as this depends on the *modus operandi* of the cause, the average sign of the electrically charged particles shot out from the sun, and whether the action is a direct or an indirect one. These are questions that must be reserved for future investigation So much interest has now been aroused in the subject that we may confidently look forward to a more careful control in future of atmospheric-electric measurements than has at times been the case, and to a wider distribution of first-class observing stations.

In conclusion, it will be of interest to refer to the fact that while the present investigation has had to be based almost entirely on the atmospheric-electric data at observatories in western Europe, the final values of the potential gradients observed aboard the *Carnegie*, in all oceans, show that the mean value of the potential gradient for 1917, the year of sunspot maximum, was about 20 per cent greater than the mean value in 1921, near the year, 1923, of sunspot minimum This result corresponds well with the average corresponding change at the western European observatories.

[7] See *Terr. Mag.*, vol 29 (1924), p 181
[8] *Terr. Mag.*, vol 29 (1924), pp 175-179

Obituary.

Prof. A. Dendy, F.R.S.

PROF. ARTHUR DENDY, whose death occurred on March 24, in King's College Hospital, at the age of sixty years, was educated at the Manchester Grammar School. On leaving school he proceeded to the Owens College, where he became one of a small band of distinguished zoologists trained by the late Prof. A. Milnes Marshall. He was the first of the students of the old Victoria University to gain a place in the honours school of zoology. Soon after he took his degree in 1885, he went to the Biological Station at Millport, and as a result of the work he did there he published his first two papers, one on a twelve-armed specimen of Antedon and the other on the regeneration of the visceral mass of the same crinoid.

Although Dendy never lost his interest in the group of Echinodermata, it was for his wide knowledge and brilliant researches on sponges that he was destined to become a world-wide authority. He was called to London as an assistant in the British Museum (Natural History), and undertook to complete for publication the memoir on the monaxonid sponges of the *Challenger* expedition, which had been left unfinished owing to the serious illness of Mr. Stuart Ridley. He set to work with his characteristic energy and skill, and this "highly satisfactory" memoir was published in 1887.

In the following year Dendy was appointed lecturer in zoology in the University of Melbourne, a post he held until 1894, when he was promoted to the professorship in the same subject in the Canterbury College of New Zealand.

In the rich and extremely interesting fauna of Australasia, Dendy found full scope for his brilliant abilities in zoological research, and he published in rapid succession a long series of papers on the anatomy and development of some of the most interesting animals of that region. Apart from some excellent papers on sponges, he wrote on land planarians, on the land nemertine (Geonemertes), on the remarkable polyzoan Cryptozoon, on Holothurians, and on the Collembola. His valuable papers on the oviparous species of Peripatus greatly enriched our knowledge of this extremely interesting and archaic arthropod, and his study of the pineal eyes of the New Zealand lamprey Geotria threw important light on the history of these remarkable vestigial structures previously discovered in Sphenodon by his friend—also an old Owensian—Sir Walter Baldwin Spencer. On reaching New Zealand he lost no time in going in search of Sphenodon itself, and, on finding that there was serious danger that the enterprise of collectors would lead to its early extinction, he made urgent and successful appeals to the Government to pass measures for its protection He was the first to write an account of the development of this reptile, and to record many important features of its anatomy and natural history.

In 1902 Dendy came back to England on a visit, and was given the hospitality of the Zoological Department of his old University in Manchester to enable him to pursue some investigations on which he was engaged Here he completed his description of the aberrant floating hydroid Pelagohydra and examined sections through the brain of the Ammocoetes larva In studying the anatomy of the Geotria in New Zealand, he had discovered a pair of ciliated grooves lying beneath the posterior commissure of the brain, and he found these grooves to be even better developed in the brain of the young Petromyzon. On these researches he published an interesting paper, which appeared in the Proceedings of the Royal Society in 1902. His studies on these brains led him to the investigation of another structure in the nervous system of vertebrates, namely, Reissner's fibre. On this subject, also, he made a very important communication to the Royal Society in 1910.

While he was in England on this visit, Dendy heard of the vacancy in the chair of zoology at Cape Town. He applied for the post and was appointed. But he remained in South Africa only two years, as he received the appointment to the professorship in King's College, London, in 1905, vacated by the retirement of the late Prof. F. J. Bell. He held this chair until his death. He was elected a fellow of the Royal Society in 1908.

In London Dendy carried on his teaching and researches with increasing energy and success, and under his guidance King's College soon became recognised as an active centre of research in his subject. He put together some of his teaching notes in the form of a book entitled "Outlines of Evolutionary Biology," which was published in 1912 and has already reached a third edition, and he also wrote an interesting little book entitled "The Biological Foundations of Society," which was published in 1924.

The last important work he wrote was the memoir on the Antarctic sponges reviewed in NATURE of March 7, p 330, but a preliminary note published in these columns on February 7 showed that he had in hand a paper in which he was prepared to maintain the rather startling proposition that the spicules of siliceous sponges are formed by the skeleton-forming cells enveloping migratory symbiotic organisms resembling micrococci. Many of his friends looked forward with much interest to the fulfilment of his promise made last December to maintain this thesis at the next meeting of the British Association.

Dendy was a man with a very striking and impressive personality, a fine speaker, and a clear and sympathetic teacher. His father was a well-known Unitarian minister. One of his sisters, Miss Mary Dendy, is widely known for her philanthropic work, particularly in connexion with the care and education of feeble-minded children. Another sister married Dr. Bernard Bosanquet, and is herself a well-known writer.

S. J. H.

WITH the sudden and untimely death of Prof Dendy, we have lost the only man in England with a catholic knowledge of sponges, and probably the leading authority of the two or three in the world who could be classed with him He was a biologist with wide scope of learning and research as well as a spongologist, but it is of his work on sponges only that I am competent to write

A catalogue of Dendy's papers on sponges would be long. They begin in 1886, when he was twenty-two, with Ridley and Dendy's "Preliminary Report on the Monaxonida . . . *Challenger*"; they end with a letter, unseen by me as I write this (March 26), which appears in NATURE for March 28, and shall remain in these columns unanswered. Ridley and Dendy's classic *Challenger* monograph (1887) was written as to some five-sixths by Dendy, a wonderful piece of work for so young a man Then came careful anatomical and histological studies of single species (*Q.J.M.S.*, 1888 *et seqq.*). Beside them the "Monograph of the Victorian Sponges . . . Homocœla" (1891) described several important new forms, of some of which we have little added information—one is now recognised as of generic rank by the name Dendya, not conferred by its discoverer. But the contemporary importance of the "Monograph" was that it carried on Poléjaeff's revolt (*Challenger* "Calcarea," 1883), and struck loose from Haeckel's "Kalkschwamme," and in this it was followed by "Observations . . . and Classification of the Calcarea Heterocœla" (1893, *Q.J.M.S.*), which made a serious and valuable attempt at classification *de novo*.

It would be a long article which should follow Dendy from youth to maturity and from maturity to the admirable work of his last years; we may say briefly that Vosmaer's "Bibliography" to 1913 (in press) gives him thirty-five publications, mainly before 1898, and that his masterly "Reports" since 1913 on collections of sponges add up to 460 quarto pages of print. They are all good As in other descriptive monographs, there is much which is only readable to the colleague whose interest has been aroused in the

organism described. But there is no slovenly work, and nothing written without purpose, responsibility, and accuracy.

Dendy was above all truthful in record. I have followed much of his work very closely in calcareous sponges, and I have never found the sign of anything described which I had reason to doubt had been seen. He was a beautiful draughtsman, and I have always considered that I could trust one of his drawings as if I had seen the specimen Four or five years ago I questioned him as to certain details in his early illustrations (*a*) of the collar-cells of Halichondria, (*b*) of the pore-canals of *Leucosolenia stolonifer*. He showed me under the microscope the actual sections from which the drawings had been made, a third of a century earlier, and the fidelity was perfect

Dendy's life's work as regards sponges was to accomplish a revised classification of the whole group and of their spicules. He was an evolutionist to the core, and believed in the evolutionary chain not only for all forms of sponges but also for all their spicules. His work, however, led him to the conclusion that it is impossible to consider the detailed form of spicules to be evolved for functional advantage to the sponge, and in the case of the two-disced spicule of Latrunculia he, in conjunction with Prof. J. W. Nicholson, gave a most important physical theory of the nodal position of the discs.

I have elsewhere expressed disagreement with his classification. But Dendy had investigated probably more forms of sponges than any one else has ever done, unless possibly Topsent, Hentschel, or Vosmaer. His works constitute a logical catalogue of their forms and of their spicules, illustrated almost entirely by himself with innumerable accurate drawings and accompanied by clear and careful description. He has made research on sponges easier for all who come after him; he has left order where there was much chaos

Dendy enjoyed public discussion and hard hitting, given and received without disturbing private friendship Veracity in record, swift work, accurate observation, clear description, untiring industry and enthusiasm for biological knowledge—these were his characters.

In ten years have died Minchin, Maas, Vosmaer, Dendy The evening grows chilly.

GEO. P. BIDDER

MR. THOMAS HUGH POWELL, who died in London on February 19, was a remarkable personality in the microscopical and photographic world He devoted practically the whole of his life to the development and improvement of appliances in connexion with microscopes and photography, and, following in the footsteps of his father, Mr. Hugh Powell, was responsible for many progressive inventions. When Mr. Powell's father died in 1883, it was said of him in an obituary notice in the *Times* that he was the first optician in England to construct object glasses on Amici's "immersion" system. After making a considerable number of one-eighths, one-sixteenths, one-twenty-fifths, and one-fiftieths, he completed, with the assistance of his eldest son, who has just died, an object glass of this kind having a focal length of one-eightieth of an inch. The formula of the "homogeneous immersion" system was the subject of special attention on the part of Mr. Powell, sen., but failing health compelled him to rely on the efforts of his son, by whom object-glasses on this formula, having the highest apertures on record, were constructed. Mr. Powell was within a month of his ninety-third birthday at his death, having been born in March 1832. He was believed to be the oldest member, both in age and in length of membership, of the Royal Microscopical Society and the Quekett Microscopical Club, and displayed an active interest in his life-work to within a short time of his death.

WE much regret to record the death of Mr. Robert Standen, Senior Assistant-keeper in the Manchester Museum, who died on March 15, aged seventy-one years. He was born at Goosnargh, near Preston, and spent his whole life in Lancashire, forming one of the band of first-rate field naturalists who have done so much work on the fauna and flora of the north-west of England. He had wide knowledge and experience, and would have something of interest to say about most of the live things met with on a country walk, and to this he added a skilful museum technique and a scholar's knowledge of his special group—mollusca—on which he wrote many papers both on the British and, in conjunction with Dr. Cosmo Melvill, on foreign forms. In recent years he was active in promoting interest in neglected groups and quickly made himself an authority on wood-lice: here and everywhere he never grudged time and trouble spent on helping any one who asked for assistance. His services to natural knowledge were recognised by the M.Sc. degree which was conferred upon him by the University of Manchester in 1924.

THE issue of the *Physikalische Zeitschrift* for February 15 contains an obituary notice of Gustave Jaumann, professor of physics in the Technical School of Brünn, from the pen of his colleague Dr E. Lohr. Jaumann was born at Karansebes in South Hungary on April 18, 1863, and was educated in Prague and Vienna. In 1885 he became assistant to Mach at the University of Prague, in 1893 professor of physics there, and in 1901 at Brünn, where he died suddenly on July 21, 1924. He published a number of experimental investigations on electric discharges and cathode rays, but is probably best known by his theoretical work, which is in great measure co-ordinated in his 1918 paper on the physics of continuous media.

THE editors of the *Journal of Genetics* inform us that they have received, with great regret, news that Mr. V. Issayev, of the University of Leningrad, has been killed in the Caucasus. The last number of that Journal contained a remarkable memoir by Mr. Issayev, giving the results of novel and curious experiments on grafting different species of Hydra together (noticed in NATURE, March 21, p. 438).

WE regret to announce the following deaths:

Mr W. W. Rouse Ball, fellow and formerly tutor of Trinity College, Cambridge, on April 4, aged seventy-four.

Prof. Burt G. Wilder, professor of neurology and vertebrate zoology in Cornell University from 1867 until 1910 and afterwards emeritus professor, and president in 1885 of the American Neurological Association and in 1898 of the American Association of Anatomists, on January 21, aged eighty-three.

Current Topics and Events.

A LETTER sent to us addressed from the Nanking Branch of the Science Society of China is of particular interest now that the China Indemnity (Application) Bill, having passed the Committee stage, is down for third reading in the House of Commons It is satisfactory to learn from the writer, Mr. Co-Ching Chu, that this important Society is in full agreement with our editorials of August 30 and November 29 last, not only on the principles and the chief details of expenditure there enunciated, but also on the object underlying our proposals, namely, the promotion of mutual understanding and goodwill between England and China At the same time our correspondent utters a word of warning to our legislators Expenditure on purposes other than educational and cultural may, he says, help to prolong the political turmoil in China, and to increase the antagonism towards foreigners Coming from a responsible Chinese, these are arresting words. It is, however, unfortunate that he credits the unfounded rumour that the change of personnel on the Advisory Committee indicates a reversal of policy, by turning from education to railways, and in particular to a line along the Yangtze Valley

ALTHOUGH railway construction is not ruled out by the vague wording "educational or other" purposes which Mr M'Neill has persistently retained in the China Indemnity (Application) Bill, such usage has been expressly disclaimed by him in recent debates He specifically declared to the Standing Committee that, while the main object of this Government, as of the last, is educational, the Government refuses to pledge itself even to education, if some other ameliorative object urgently presents itself While such an attitude is understandable in normal circumstances, it is not merely unstatesmanlike but futile now when an anti-foreign feeling is gathering head in China, and the Chinese are accepting the views pressed by nationalistic agitators that the remitted moneys are all of the nature of returned loot In any event, the sums remitted are so small when the size and the needs of China are considered that if distributed in driblets, as seems contemplated, no appreciable result will ensue Certain institutions will, of course, benefit, but so far as the goodwill behind our gift is masked by vagueness, our allocations, however carefully considered, will make no call on the goodwill of a responsive people, while the timid handling of co-operation, contrasting unfavourably with that of other remitting Powers, will do nothing to stem the tide that day by day runs more strongly against the foreigner and all his works.

A SMALL volume by Dr. Marie Stopes, entitled "The First Five Thousand," being the first report of the results achieved by the Birth Control Clinic established by Dr. Stopes and her husband at Marlborough Road, Holloway, has been published by Messrs. John Bale, Sons, and Danielsson, Ltd. That some form of birth-control is the only means of regulating the tendency of the population of Great Britain to increase beyond the limits of our food supply is a conclusion which has forced itself on more and more thinkers, both in the biological and economic spheres But birth-control is a subject against which more emotional prejudice can be aroused, than against almost any other subject of discussion In the volume before us Dr. Stopes gives a full, clear account of the foundation and organisation of the clinic, and of the care that is taken to prevent the knowledge imparted from being used for purely immoral purposes The sound rule is adopted that full advice is given only to women who have already borne one child Dr. Stopes is fully convinced (perhaps some of her critics think too fully convinced) that the method which she adopts is the only safe and innocuous one, but she certainly brings forward strong evidence in support of her contention, for out of 5000 cases she can only find evidence of 42 failures, whereas to judge from the figures which she gives, the percentages of *successes* when other methods have been employed has never risen above 25 per cent. Dr Stopes would perhaps admit that the storm of criticism, of which she has been the target, has led her to perfect the means employed, so that these criticisms shall be deprived of their ground After all, there is no getting away from the fact that the practice of birth-control is widely spread among the middle classes, and to deny the knowledge of the means to the poor, who need it far more than the middle-classes do, is a proceeding which no parliamentary language is strong enough adequately to criticise

THE Chemistry Section at the British Empire Exhibition this year is again being organised by the Association of British Chemical Manufacturers. In a purely business exhibition, designed to bring buyers and sellers together, a chemical display necessarily consists of samples of products This year's exhibit, however, will be designed mainly to interest the public and give the visitor some idea of the extraordinary part which chemistry plays in the national life. For example, instead of the individual dyestuff makers each having their own display, there will be a large combined exhibit which will show, not only the immense variety of articles into which colour enters, but also what beautiful effects can be obtained by the use of dyestuffs made in Great Britain. The Scientific Section, which created so much interest last year, will also be remodelled The public has now some idea of the position of Great Britain as a leader in scientific research It is proposed, therefore, to show how strikingly connected are the various stages in manufacturing processes, from basic materials to the finished product This subject will be treated by taking as a basis coal, salt, and food From the consideration of, for example, the raw coal, the visitor will be taken through the various stages of distillation of coal, the products of such distillation, such as tar and ammonia, the treatment of tar, and the resulting intermediate products which lead up to the manufacture of dyestuffs The production of benzol, of disinfectants, of fine chemicals, of medical products,

and the numerous other chemicals obtained from coal will also be illustrated. In this way it is hoped to demonstrate the importance of chemistry and chemical research in our daily life

"CHEMISTRY IN THE SERVICE OF THE STATE" is the title of a brochure, published by the Department of Chemistry of the University of Wisconsin, which sets out clearly and concisely the importance of chemistry in industry and in private life. Unlike some recent propaganda, this publication is practically free from overstatements, and within its limits it may be said to constitute an exceedingly able presentation of the case, it indicates in plain language the relations of chemistry to agriculture, to medicine, and to some important industries, and outlines briefly a few of the urgent problems that await solution The value of chemistry as a handmaid to other sciences appears to be well appreciated in Wisconsin, for we read that 89 per cent of the 1380 university students who took chemistry in 1923 were specialising in other subjects Perhaps the weakest section of the pamphlet is that concerning the cultural value of chemistry, but the weakness resides largely in the subject itself, for chemistry is essentially a material science, and culture connotes much more than a knowledge of the transformations of matter The authors therefore do well to emphasise the value of chemistry as a field for the exercise of the scientific method, but the implication that ability acquired in this sphere is transferable to everyday life would be strenuously resisted by many modern psychologists Further, the artist and the moralist would demur to the statement that the main business of life is to adapt ourselves to our environment. Does not the chemist himself seek to make his environment subservient to his own ends?

THE Ministry of Agriculture has recently issued a brochure of eight pages entitled "Wasps" Information is sought by numerous inquirers every season as to the species of wasp that happens to have attracted notice, while queen wasps are frequently mistaken by the uninitiated for the larger species or hornet These difficulties should be got over by the present publication, since all the seven species of British social wasps are clearly described in non-technical language, while identification is further aided by the remarkably well-executed coloured figures of all the species The letterpress includes a short account of the habits, nest-building, methods of destroying nests, etc., together with some cautiously worded observations on the food of wasps. The reader will gather from the facts brought forward that, although wasps may prey upon a certain number of noxious insects they are, on the whole, not to be regarded as beneficial The recent innovation of issuing pamphlets of a fuller nature than the usual leaflets of the Ministry, and illustrated by coloured plates, is to be commended. Various insects of economic significance require this fuller method of treatment, and it is to be hoped that the practice will be extended Brochures of a similar character on the frit fly, wireworm, certain fruit pests and other subjects would probably meet with a wide demand. Characteristic damage to plants by pests is often made far more easily recognisable to the agriculturist and fruit-grower through the medium of accurate coloured illustrations than by detailed descriptions and black-and-white figures The wasp pamphlet is priced at the low figure of 4*d*, post free, and can be obtained from the Ministry's Offices at 10 Whitehall Place, London, S W 1

THE output of mathematical research from the Masaryk University, founded in Brno in 1919, is already such as to show that an active school of post-graduate mathematics has been instituted there. A parcel of 46 recent memoirs, edited by M. Hostinský, and issued separately in Brno as "Publications de la Faculté des Sciences de l'Université Masaryk," contains research work, mainly on pure mathematics, carried out recently by some twenty authors in Czechoslovakia Typical examples are Hostinsky's "Notes sur l'équation de Fredholm," "Kolaček's "Les tremblements de terre Carpathiques sur le territoire de la République Tchécoslovaque," Kaucky's "Sur une équation singulière de Volterra de première espèce," Seifert's "Remarques sur une surface cubique à point uniplanaire," Boruvka's "Sur les racines imaginaires de l'équation $\Gamma(z)=a$," and Lerch's "Études sur la théorie des résidus quadratiques suivant un module premier" Most of the memoirs are printed in Chech, and followed by a French translation or abstract Nearly all of them show that the authors are familiar with the literature of their subjects As a whole they prove how seriously scientific research is being pursued in a new university, despite the economic conditions of eastern Europe If this rate of progress is maintained we foresee that the world of science will soon reckon the Masaryk University to be on a par with universities supported by greater wealth and with more age and tradition behind them.

THE question of the seat of the mechanism of aural analysis was brought strongly into notice some years ago by the publication of Sir Thomas Wrightson's "Analytical Mechanism of the Internal Ear." In that book, Wrightson, supported by Sir Arthur Keith, gave reasons for the view that the internal ear does not contain any analysing mechanism, that the individual nerve fibres have no characteristic individual function and act only in mutual support as transmitters of influence to a cerebral centre of analysis On that view the ear misses the opportunity of analysis which Helmholtz regarded the basilar membrane as furnishing Holders of it scarcely give sufficient weight to the knowledge and scientific judgment of Helmholtz when they conclude that the membrane cannot act as he considered it to do. A recent publication, "The Mechanism of the Cochlea," by Drs. Wilkinson and Gray, gives strong support to Helmholtz's view by means of scaled models. In "Some Questions of Phonetic Theory," chap. vi. (separately published), Dr. W. Perrett criticises adversely Wilkinson's and Gray's discussion. Unfortunately, the sarcastic style in which a large part is written is scarcely appropriate in a scientific discussion.

IN the annual address to the Asiatic Society of Bengal, delivered on February 4, the president, Sir Rabindra Nath Mookerjee, exhorts the members of the Society to renewed activity and appeals for the support of Princes and Zamindars as well as commercial magnates to enable the Society to continue and extend its work. The present position of the Society is one of considerable moment to those in Great Britain who are interested in those researches in India with which the Society concerns itself, and it may be hoped that the exhortations of the president will bear fruit. The address, which is a summary of the history and achievement of the Society since its inception in 1784, provides much material for reflection on the social and political changes which have taken place in that period in their relation to Indian studies. It is noted that whereas at one time research was largely, indeed almost entirely, in the hands of Indian Civil Servants, officials have now almost ceased to take any part in the Society's work, and there has been a great falling off in the interest shown by Europeans generally. The Society has great traditions, and European students now look to the natives of India to carry on these traditions worthily.

IN the issue of *Science* for February 20, Prof. Richard Hamer, of the University of Pittsburgh, Pa., enters a plea for naming the missing element of atomic number 43 before it is discovered; in view of the work of Bosanquet and Keeley (*Phil. Mag.*, 1924 (6), 145-147) and of others, he thinks that the discovery cannot be long delayed, and also that by taking time by the forelock in this manner, subsequent controversy, like that which followed the discovery of hafnium, will not arise. Prof. Hamer appeals to the scientific world to name the element "Moseleyum," in honour of the young British physicist who fell in Gallipoli, and to give it the symbol "Ms." In our view it would be a fitting tribute to the brilliant work of Moseley to perpetuate his name in some such way. Hitherto, no chemical element has been named after an individual (we exclude mercury, tantalum, thorium, and titanium for an obvious reason), and opinion may be divided on the advisability of making the innovation. It is, however, a mistake to be bound by precedent in such a matter, and the only objection we can foresee to the adoption of Prof. Hamer's suggestion is that the word is not particularly euphonious, and is rather suggestive of certain sepulchral monuments; but it might be argued that even this suggestiveness is not inappropriate, inasmuch as mausoleums are erected, as a rule, to the memory of the illustrious dead.

PROF. F. SODDY, professor of chemistry in the University of Oxford, has been elected a corresponding member of the Russian Academy of Sciences.

THE period of Summer Time in Great Britain will begin this year at 2 o'clock Greenwich mean time on the morning of Sunday, April 19. Summer Time in France and Belgium began on the night of Saturday-Sunday, April 4-5.

PROF. W. WIEN, professor of experimental physics in the University of Munich, will deliver the tenth Guthrie Lecture of the Physical Society of London on Friday, April 24, at the Imperial College of Science, South Kensington. The subject of the lecture will be "Recent Researches on Positive Rays."

AT the meeting of the Royal Geographical Society on Monday, April 6, the president announced that His Majesty the King has been pleased to approve the award of the Royal Medals of the Society as follows:—the Founder's Medal to Brig.-Gen. the Hon. C. G. Bruce for his life-long geographical work in the exploration of the Himalaya culminating in his leadership of the Mount Everest Expeditions of 1922 and 1924; the Patron's Medal to Mr. A. F. R. Wollaston for his explorations and journeys in Dutch New Guinea, Central Africa, and many other parts of the world. The Council has made the following awards:—the Murchison Grant to Mr. Eric Teichman for his travels in China and Tibet, the Back Grant to Capt. Bernier for his work in the Canadian Arctic, the Cuthbert Peek Grant to Mr. Michael Terry in support of his proposed journey across Northern Australia; and the Gill Memorial to Major R. E. Cheesman for his journey to the deserts of Jafura and Jabrin.

IN order to preserve the fauna of the Southern Ocean the Government of France has issued a decree constituting a national Antarctic reserve in certain territories belonging to France. According to *La Geographie* for January, the reserve includes all the Crozet Islands, St. Paul and Amsterdam Islands, and on Kerguelen certain islets on the north coast and parts of the south coast to a depth of 1000 metres from the land. Within these areas it is forbidden to hunt whales, seals, or sea-birds. No special means are proposed for enforcing these prohibitions, which must naturally depend on the good faith of the hunters who frequent these seas.

DURING two months following the Japanese earthquake of 1923, Mr. H. M. Hadley examined several hundred buildings in Tokyo and Yokohama that were damaged by the earthquake as well as several hundred others that escaped injury (Bull. Seis. Soc. of America, vol. 14, 1924, pp. 6-8). His general conclusion is that, whatever the material used—whether the buildings were steel-framed, of reinforced concrete, of brick or of wood—those that escaped were so framed and braced that they moved as a whole when their foundations were shaken. Of the large steel-framed buildings in Tokyo, those undamaged owed their immunity to the extensive use of reinforced concrete wall construction. A small amount of properly distributed wall construction at the corners and elsewhere was sufficient to protect buildings from the slightest damage. But, though earthquake-proof construction can be secured with any material, the safest and most economical results can be obtained "with structural steel or reinforced concrete, both embodying an adequate amount of reinforced concrete wall construction."

A REPORT on the meteorological service of Australia for the year 1922–1923 has been submitted to the Parliament of the Commonwealth by Mr. H. A. Hunt, the Commonwealth Meteorologist. The report deals with the Central Weather Bureau at Melbourne and with the Weather Bureaux at Sydney, Brisbane, Adelaide, Perth, and Hobart. At the Central Weather Bureau at Melbourne, reports are received daily from a large number of stations, embracing the adjacent islands, and from stations in New Zealand. By the aid of these reports, the South Pacific Islands are warned when cyclonic conditions are developing. The data are also used for the ordinary storm-warning service for the protection of the Queensland and New South Wales coasts and of shipping traversing the waters eastwards from Australia Rainfall maps showing the total rainfall for each month for several stations are published on the first day of the following month. Aviation forecasts are regularly issued, and the Aviation School at Point Cook is informed whenever easterly gales are expected; the latter seems an admirable precaution Ocean forecasts and storm-warnings, in addition to being distributed to coast stations, are broadcasted to ships at sea. The prevailing conditions of the weather round the coast are also supplied to radio stations. A careful analysis is made of the forecasts, on the average of fourteen years, the official forecasts verified for the States and for the Commonwealth as a whole reaches 87 per cent. There are 484 climatological and 5912 rainfall stations distributed throughout the Commonwealth and the adjacent territories.

Our Astronomical Column.

NEW COMETS —Still another comet, 1925 *c*, has to be added to the list of discoveries It was discovered by Mr. Orkisz in Russia on April 4, and was observed by Mr. Moller, at Copenhagen, on April $5^d\ 2^h\ 52{\cdot}7^m$ G.M.T. in R.A. $22^h\ 26^m\ 45\ 13^s$, N. Decl. 16° 37′ 19″. The motion in R.A. is small, that in declination is about 1° daily northward. The magnitude is 8. The comet is in Pegasus, and must be looked for in the east just before dawn

Both Schain's and Reid's Comets were observed by Dr Steavenson as follows.

Comet	G.M.T.	R.A. 1925.0	Decl. 1925.0
Schain	Apr. $2^d\ 1^h\ 55\ 6^m$	$11^h\ 31^m\ 26{\cdot}1^s$	+ 2° 27′ 37″
,,	,, 3 22 42·8	11 28 11·0	+ 2 35 49
Reid	,, 2 1 6·4	13 21 47·7	− 22 22 49
,,	,, 4 0 40·9	13 19 32·7	− 22 53 54

The following orbit of Schain's Comet is by Dr. A. C. D. Crommelin It is still subject to appreciable correction, but is much nearer the truth than Kobold's orbit, which made perihelion occur in November 1924.

T	1925 Nov. 2·58 G.M.T.	
ω	216° 35 5′	1925·0
Ω	357 30 6	
i	146 6 9	
log q	0·59512	

The perihelion distance is the second greatest on record, being exceeded by that of the comet of 1729 alone

EPHEMERIS FOR 0h GREENWICH

	R.A.	N. Decl.	log r	log Δ
April 11	$11^h\ 16^m\ 4^s$	3° 6′	0·6351	0·5355
,, 19	11 3 24	3 36	0·6323	0·5438
,, 27	10 51 56	3 59	0·6296	0·5546

The comet should be in sight for two years or more. It is at present not far from the orbit of Jupiter.

The following orbit of Reid's Comet is by Mr Moller and Miss Vinter-Hansen, of Copenhagen Observatory Almost identical elements were found by Mr. G. Merton

T	= 1925 July 22·951 G.M.T.	
ω	= 244° 19 8′	1925·0
Ω	= 7 41 6	
i	= 30 14·8	
log q	= 0·29608	

EPHEMERIS FOR 0h GREENWICH.

	R.A.	S. Decl.	log r	log Δ
April 10	$13^h\ 12^m\ 35^s$	24° 25′	0·3693	0·1345
,, 14	13 7 26	25 25		
,, 18	13 2 6	26 23	0·3601	0·1194
,, 22	12 56 39	27 19		
,, 26	12 51 12	28 12	0·3513	0·1099

The comet is fairly bright, with a distinct nucleus, but is too low down for convenient observation in England

SPECTROSCOPIC PARALLAXES OF 520 STARS OF TYPES F TO M.—Mr. W. B. Rimmer in vol. 64 of the R.A.S. Memoirs gives a full discussion of the absolute magnitudes and parallaxes of 520 stars from observations at the Norman Lockyer Observatory, Sidmouth. The curves connecting strength of lines with absolute magnitude were deduced from (1) moving-cluster parallaxes, (2) parallactic motion, (3) trigonometrical data; the last fails for the distant stars of high luminosity.

Special attention was given to the exact spectral type of the stars, published results being revised in several cases. Comparison of results is made with those of the Dominion Observatory, Victoria, B.C., the agreement being satisfactory.

On the whole the new parallaxes slightly exceed the trigonometrical ones, but the mean difference is only about 0·002″. The parallax of Polaris is given as 0·014″, in good agreement with the value 0·016″ obtained from the law connecting luminosity with period in Cepheids That of Betelgeuse is also 0·014″, which is near the mean of other determinations. For α Centauri and 61 Cygni the values found were 0·770″ and 0·300″, but these are more a check on the graduation of the curves than of the parallaxes themselves.

THE OLD BABYLONIAN VENUS TABLETS —A note in these columns more than a year ago described Dr. Fotheringham's work in dating these tablets, which are an important source for early chronology. Father Kugler was the first to deal with the problem, and fixed on the dates −1800 to −1780 for the series of observations contained in the tablets. Dr. Fotheringham made the dates 120 years earlier (they must be shifted by multiples of 8 years, owing to the fact that both Venus and the moon nearly repeat their positions relatively to the sun after this period). Dr. C. Schoch has lately been visiting Dr. Fotheringham at Oxford, and has just published a pamphlet entitled "Ammizaduga," which makes a further alteration in the dates, making them −1856 to −1836. One difficulty in the research is the question of intercalary months, with regard to which Ammizaduga appears to have changed the system. Light is thrown on them by study of the tablets relating to the harvests of dates and barley, as these give an indication of the position reached by the sun. It is claimed that, taking all the circumstances into account, the dates now adopted are the only ones that satisfy all the data. The mean dates of Nisan 1 reduced to Julian reckoning are given as follows:

Year	0	Nisan 1 =	
,,	−1000	,,	Mar. 30, 1 day before equinox.
,,	−2000	,,	Mar. 29, 9 days ,, ,,
,,	−3000	,,	Apr. 1, 14 ,, ,, ,,

Research Items.

PHYSICAL CHARACTERS OF SERBIAN GYPSIES.—Dr Viktor Lebzelter has recorded in the Journal of the Gypsy Lore Society, Ser. 3, vol 3, Pt 4, the results of anthropometric observations made in 1916 on forty-five Serbian gypsies who were prisoners of war. Gjargjevič has classified the gypsies of Serbia into three strata, of which the first and third are Moslems and the second Christian—Rumanian gypsies who with the other Rumanian inhabitants of Serbia entered the country in the seventeenth century. The subjects of Dr Lebzelter's observations belonged to the Christian stratum, though only seven called themselves Rumanian gypsies. They came from north-west Serbia and all were sedentary. They were remarkably homogeneous. Their hair was thick, and smooth like that of Hungarian and Bosnian gypsies. In the majority of cases it was black, but ranged to light brown. The colour of the iris in eighteen cases was dark brown, but black-brown, brown, greenish-grey, brownish-grey, and greenish-brown also occurred. The average height was 1627 mm.; 24 per cent. were tall or very tall The cephalic index ranged from 72·49 to 88 76, the average being 78·3 From an analysis of published measurements of Balkan gypsies, 952 individuals, Dr. Lebzelter concludes that the original type is dark, smooth-haired, moderately short, mesocephalic, moderately hypsicephalic, leptorhine, and perhaps leptoprosopic. The Serbian gypsies show this original element more clearly than the Hungarian gypsies

TRIBES OF THE GRASSLAND AREA, CAMEROON.—Capt L. W. G. Malcolm has contributed to *Mitt Anthrop. Gesellschaft in Wien*, Bd. 55, a detailed study of the physical anthropology of the Eyap tribe of the Central Cameroon. The observations were confined to males, forty-four measurements being taken on each of one hundred individuals between the ages of twenty and fifty years out of a total adult male population of not more than 700. Five albinos with eyes hazel to green in colour were seen, and *leucoderma* on hands and legs is common in both sexes. Deformations include elongation of the head, the infant's head being moulded by the mother soon after birth, moulding of the nose, piercing of ears, lower lip, and septum of the nose, chipping of the teeth, circumcision, cicatrisation, and tatooing. The ratio of males to females is 25·92 per cent The rate of infant mortality is high, and the number of children in polygamous families low. The head-chief, with more than 100 wives and concubines, had twenty-five children, of whom only five were living. Other chiefs with wives numbering between twenty and fifty had even fewer, and in nearly all cases there are more children by monogamous marriages. The maximum head-length recorded is 205 mm., the minimum 180 mm., the mean cephalic index 79·37. While the Eyap are mesaticephalic, according to the usual classification, they show a strong tendency to brachycephaly.

THE RELATIVITY OF TIME.—An article in the February issue of *Scientia* by Prof. F. Severi of the University of Rome deserves the attention of all who are interested in the philosophical aspect of the principle of relativity. It is an examination of objections of a general kind to the relativity of time. The argument deals with three objections to Einstein's definition of simultaneity: "Two flashes produced at equal distances from me are simultaneous if I perceive them at the same instant." The first objection is that the definition depends on a concept of simultaneity which is spontaneous and intuitive, the very concept the definition seeks to get rid of. The second is that logically the definition is circular, for it presupposes that the light reaches me from the two places at which the flashes are produced in equal times, whilst I can only measure intervals of time if I already possess the notion of simultaneity. The third is that the hypothesis of the independence of the velocity of light of the motion of the source and of the observer is *a priori* untrustworthy, because it precludes our thinking of a light phenomenon in the concrete, that is, as a phenomenon arising, developing, and finishing within its own environment. Prof. Severi, in replying to these objections, concludes a very lucid argument with the opinion that, so far from the principle of relativity having, as some have claimed, removed the last anthropomorphic vestiges from science, absolute time is both egocentric and anthropomorphic, and, however we regard the universe, whether as a reality external to us or as the projection of a construction of our mind, the maxim of Protagoras remains profoundly true: man is the unity of the measure of the universe

DIFFERENTIATION OF BREEDS BY SEROLOGICAL METHODS.—The *Journal of Immunology* (vol 9, No 6, November 1924) contains a paper by W Bialosuknia and B Kaczkowski, of the Institute for Serological Research and the Animal Breeding Department of the Institute for Agricultural Research in Poland, on the problem of determining the descent of certain breeds of sheep by applying the methods previously adopted by Londsteiner and others in their researches on the isoagglutination of blood among races of men. The sheep employed in the investigation were South-downs, a local Polish breed, a mountain breed from the Carpathians and Karaculs. It was definitely shown that whereas certain types of erythrocytes are agglutinated by all the sera having the capacity for agglutination, others are only agglutinated by certain sera, and that the sheep investigated fell readily into groups according to the results of the isoagglutination test It was impossible, however, to distinguish the breed of sheep by this test, since the same groups were present within the various breeds. Nevertheless, evidence was obtained of the existence of serological characteristics which could be transmitted in accordance with Mendelian expectation It was found, moreover, that external factors played no part in the phenomena of isoagglutination The authors are pursuing the subject further

HERRING INVESTIGATIONS.—The report for 1923–24 of the Dove Marine Laboratory, Cullercoats, Northumberland, drawn up by Prof Meek, contains an account of a large amount of work Following up his researches on herrings Mr B Storrow, who for many years has made this his speciality, contributes a detailed paper on herring shoals in which he reports on more than 7000 examples from various localities. He finds that those from the Smalls and from St. Ives were of mixed growth and practically all mature, making it difficult to fix separate races From examination of the scales of the various herrings he makes the suggestion that the larger growth variations, as indicated by these scales, are to be interpreted as representing periods of migration to or towards areas of greatest growth which are oceanic, and he concludes that in the case of the North Sea herrings, a northerly migration is necessary to bring about a more rapid increase in size. Mrs. Cowan adds a report on the size of the herrings showing that various shoals of different sizes and ages appear at different times.

EXPERIMENTS ON ECHINODERMS.—The report for 1924 of the Marine Biological Station at Port Erin,

Isle of Man, by Prof. Jas. Johnstone, states that most of the research done at that laboratory has been published elsewhere, the amount of this work showing abundant activity on the part of the staff. In the appendix, however, there are two interesting papers, one by Mr J. Ronald Bruce, naturalist of the Port Erin Station, on the seasonal and tidal P_H variation in the waters of Port Erin Bay, and one by Mr H. C. Chadwick, research zoologist, entitled "Natural History Notes," in which he gives some recent plankton observations and describes some very interesting experiments on the vitality of the spines and pedicellariæ of echinoderms from detached portions of the test. It is shown that these may still respond to stimuli after thirteen days, and pedicellariæ alone when detached from the test may retain their vitality almost as long as when *in situ*. With regard to the unnamed larva figured in these notes, there seems no doubt that it is the free-swimming cercaria of the trematode *Pharyngora bacillaris*, which is to be found fairly commonly in the Channel in the winter months and is conspicuous in having an annelid-like tail regularly provided with setæ. The intermediate host may be a medusa or a ctenophore, in which it lives freely without encystment, and the final host is the mackerel. The parasitic ciliate protozoon *Cryptochilum boreale* in *Echinus esculentus*, from the Shetland Islands, recently described by Mr C. C. Hentschel, is found to be common in the Echini from Port Erin.

POLLEN DEVELOPMENT IN SWEET PEAS.—The extensive genetical studies of *Lathyrus odoratus* by Bateson, Punnett, and others make a critical investigation of the cytology of this species desirable. In a preliminary account of such a study (*Brit. Journ. Exptl. Biol.*, vol. 2, p. 199), Miss J. Latter describes some of the features of the pollen development. The haploid chromosome number is already known, from the work of Winge, to be seven. In the second contraction stage of meiosis, the spireme is thrown into seven radiating loops, and for this stage Prof. Gates suggests the term broxonema. Each loop consists of a pair of chromosomes end-to-end. When the thread is still very slender the arms of the loop are frequently twisted about each other near the base. This would provide a possible basis for crossing-over combined with telosynapsis. Hitherto crossing-over has only been described in connexion with parasynapsis or a side-by-side pairing of chromosome threads. The view is also expressed that the linin rather than chromatin is the probable basis of inheritance.

ANIMAL ATTACKS ON LEAD TUBING.—At the Linnean Society on March 5, Mr Gerald Loder showed a piece of lead piping from Waterloo Station, London, gnawed by rats. "The general opinion was that the rodents gnawed the metal in order to wear down their teeth, and not to reach the water or to enlarge a passage-way." The destruction of lead tubes by animals is also discussed by Prof. R. Hesse of Bonn in the *Biologisches Zentralblatt*, Part 1., for 1925. He here explains the action of the rats in gnawing through a tube of 4 mm. thick as due to their endeavour to penetrate from a cellar into a basement, an endeavour which a stream of water from the pierced pipe would presumably throw considerable cold water upon. Dr. Hesse describes other examples of metals being attacked; thus in Shanghai species of Xylocopa eat through the lead sheath on telephone cables, although it is 0·8 mm. thick. The correspondent of a cable company explains that these "wasps" mistake the cables for bamboos and bore the holes in order to deposit their eggs therein! As soon as a rough "twine braiding" is wrapped round the smooth cable, it no longer has attraction for them and they leave it alone. The same cable firm reports the penetration of a submarine cable, armouring, jute and lead sheath, by chitons, which had slowly penetrated even the lead tube presumably by the slow chemical action of acid substance excreted from the foot.

THE SARCOPT OF THE BUFFALO.—T. M. Timoney gives an account in Bull. 154, Agric. Res. Inst., Pusa, 1924, of the bionomics of this parasite as observed at Muktesar. The average number of eggs laid by a female under experimental conditions was 17 to 18, and ten days was the maximum duration of life of an egg-laying female. The incubation period of the eggs is 1 to 2 days at summer temperature, and 2 to 3 days in winter. The interval between hatching from the egg and attaining adolescence is 6 to 8 days. The ovigerous and pubescent females can withstand better than the other stages separation from their host. The author records tests with 10 per cent. creosote in olive oil, which suggests that it may be found effective in controlling this sarcoptid.

TEXTURE AND STRUCTURE.—In the *Geol. Fören. Forhandl.* Bd. 46, Dec. 1924, pp. 654-660, P. J. Holmquist summarises the different definitions and usages of the petrographic terms "texture" and "structure". There is more diversity of opinion with regard to the latter term than to the former. Iddings, for example, applies "structure" to features due to fracture, aggregation, or erosion, whereas many Continental petrologists have used the term in the Anglo-American sense of "texture", that is, to connote the manner in which the internal units of a rock are arranged. Holmquist suggests that the confusion be brought to an end by accepting the meanings given by Holmes in his recent "Nomenclature of Petrology," these being also the meanings that have long been adopted by Tornebohm and other Swedish petrologists. "Structure" is thus applied to the appearance of a composite aggregate which is itself made up of simple aggregates, and each of the latter has a "texture" due to the degree of crystallisation, the grain size, and the shapes and interrelations of the crystals or other constitutional units.

EQUIPMENT FOR ARCTIC EXPEDITIONS.—The plans of the *Terra Nova* and a detailed list of its equipment and stores during its employment with Captain Scott's expedition form one of the most recent publications of the British Antarctic Expedition (1910-13) (London: Harrison and Sons, London. 5s. net). The publication, which is edited by Col. H. G. Lyons and is entitled "Miscellaneous Data," contains also some notes on equipment and transport animals which should prove useful to expeditions of the future. It is of interest to note that the mules used by the search party in 1912 seemed far better suited to the Antarctic conditions than the ponies which Captain Scott used in the earlier stages of his southern journey. They were Indian pack-mules trained for snow work in the Himalayas. The volume also includes a short note on the tidal observations.

MOVING RAINBOWS.—In NATURE of Dec. 13, 1924, p. 860, Mr. G. B. Deodhar described some interesting observations made by him of a double and mobile rainbow. Mr. G. Fergus Wood, of the Forest Research Institute, Dehra Dun, writes to say that he happened to witness a somewhat similar phenomenon a year or so ago. He says: "I had just taken some readings with a theodolite in the early morning when an incomplete rainbow appeared in the sky above the point which I had been observing. The sky was clear, with the exception of a few clouds in the neighbourhood of the shower responsible for the bow. I elevated the telescope to look at it; as I did so the bow began to move rapidly out of the field of view so that I had

to depress the instrument to follow it. The movement was about 3°. I could detect no change in colour sequence or in radius, though the final bow seemed brighter and was complete The movement lasted less than thirty seconds" Mr. Wood does not agree with Mr. Deodhar's explanation of two bows appearing in the sky close together and with the same colour sequence. He remarks. "I am inclined to attribute both phenomena to either a reflection or refraction of the sun's rays before entering the rain, or to a reflection (unlikely) or refraction between bow and observer The latter—in the nature of a mirage effect—seems to me the most probable, since the time was favourable and magnification is frequently the result of mirage"

THE THEORY OF STRIATED DISCHARGE.—An explanation of the mechanism of the striated discharge, based on recent investigations of collisions between electrons and atoms, is given by Prof A. Günther-Schulze in the *Zeitschrift fur Physik* for February 11 He shows that in many gases, even when the collisions are inelastic, the velocity of the electrons, which move irregularly in all directions, increases in an electric field up to a definite maximum value He gives the law which governs the velocity at different distances from the cathode, where it is zero If the velocity expressed in volts is less than the excitation voltage of the gas, the losses on collision with the atoms will be small, and there will be no luminosity, when, however, the velocity reaches this point, the energy of a colliding electron will be given up to the atom, which will emit light This will take place at a definite distance from the cathode, and the first bright stria will be produced, the velocity of most of the electrons being reduced to zero It is known that faster electrons are not so likely to produce excitation as those that have the excitation velocity, and most of the former will pass on into the succeeding dark space, where they will not produce luminosity. The same is true of the electrons which have been brought to rest in the first stria, which will gradually acquire velocity as they pass through the dark space, and will excite the atoms in a second narrow zone when they have acquired the correct velocity

THE ABNORMALLY LOW VOLTAGE ELECTRIC ARC — Dr. R. Bar describes experiments with mercury vapour, argon and helium in the *Zeitschrift fur Physik*, February 19 With mercury the smallest excitation voltage ($1S - 2p_3$) is 4·7 volts, and the voltage corresponding to the resonance line 2537 Å U ($1S - 2p_2$) is 4·9 volts; but Hebb found that an arc would burn with 1·7 volts and Yao with 1·8 volts. The author's experiments were directed towards finding whether such low voltages would suffice when there were no oscillations in the current and voltage, and his result was that the lowest steady voltage which would give an arc was 2·25 volts Previous experiments by Bär, v Laue and Meyer have shown that the arc produced in helium, at 8 volts, by Compton, Lilly and Olmstead was due to oscillations in the voltage, the peak voltage rising above the critical value 19·8 volts. The author has now succeeded in producing an arc in helium with a steady voltage of 16·5 volts, using specially purified helium and a very hot cathode wire.

A SUGGESTED EXPLANATION OF THE QUANTUM THEORY.—M. L. de Broglie, in the *Annales de Physique* of January-February, assumes the existence of a periodic phenomenon, the exact nature of which has still to be determined, which is connected with every isolated "portion of energy," including electrons, protons, matter in general, and quanta of light and X- and γ rays. The fundamental idea of the theory of quanta is the impossibility of considering an isolated quantity of energy without associating with it a certain frequency, in accordance with the equation $E = h\nu$, which must be connected with the mass of the energy portion, or mobile, by the Planck-Einstein equation. Considering the question in the light of the relativity theory, it is found necessary to associate with uniform motion of a material point a certain wave propagated from it, the phase of which is displaced in space with a constant velocity greater than that of light. In the more general case of an electrically charged body, moving with variable velocity in an electromagnetic field, it appears that the principle of least action in the form given by Maupertuis, and Fermat's principle of concordance of phase, may be two aspects of a single law. The known laws of quantified trajectories can be interpreted as expressing the resonance of the phase wave along the length of closed or quasi-closed trajectories, this appears to the author to be the first physically plausible explanation proposed for the Bohr-Sommerfeld stability conditions The theory leads to a real harmony between the views of Newton and of Fresnel; but it is shown that the electromagnetic theory requires revision, though as a statistical approximation the existing theory is perfectly satisfactory in a very large number of cases The scattering of X- and γ rays, statistical mechanics, and the law of radiation of a black body are dealt with in accordance with the new theory

HOLMIUM.—F H Driggs and B S Hopkins describe in the February number of the Journal of the American Chemical Society some work carried out on holmium Holmium and yttrium were separated from erbium by fractional crystallisation of the bromates, yttrium was removed by thermal decomposition of its nitrate The ratio of holmium chloride to silver was determined, the results giving a mean value of 163 47 for the atomic weight of holmium.

THE CALOMEL ELECTRODE.—A method of preparing calomel directly in saturated potassium chloride solution is described by W W Ewing in the Journal of the American Chemical Society for February A current of 1·3 amp /dcm.^{2} at 35-40 volts was applied to the system Hg^+ KCl(sat) *N* KCl $CuCl_3$(sat) Cu^-. Calomel mixed with potassium chloride crystals and finely divided mercury collected on the mercury surface, which was continually scraped with a stirrer This method is less tedious than the older one, and the product is shown to be a dependable standard for use in the calomel electrode.

THE HABER EQUILIBRIUM.—It has recently been found that the equilibrium constant of the Haber equilibrium (hydrogen, nitrogen and ammonia) is a function of pressure, and it follows that such data can be used, at least in principle, to test assumed forms of the mass action law. Existing data must be supplemented with hypotheses, however, enabling us to pass from the properties of pure gases to those of mixtures; and L J Gillespie, in the February number of the Journal of the American Chemical Society, points out that the rule of Lewis and Randall for calculating the fugacity of a gas in a mixture offers a suitable hypothesis, provided it is made exact by the addition of a certain supplementary term based on the assumption that at large volumes the equilibrium pressure is equal to the ideal-gas partial pressure. The author shows thermodynamically that the three propositions—exactness of the modified fugacity rule, additivity of volumes and additivity of heat content—all follow from any one of the three. An experimental method is outlined for testing the author's results.

Submarine Measurements of Gravity.

RECENT years have witnessed great advances in our knowledge of the gravitational field near the earth's surface on land, but in spite of many efforts the extension of these determinations to oceanic regions has until quite lately proved a very intractable problem. It would now seem that substantial success has at last been achieved, as the result of trials of a specially designed apparatus and method during a voyage of a submarine from Holland to Java in 1923. The apparatus used is a development of one which was devised to overcome difficulties experienced in ordinary pendulum determinations in Holland, where the unusual mobility of the soil had made it impracticable to eliminate slight movements of the supports. These motions were rendered innocuous by suspending from the same plate several pendulums, having very nearly equal periods of vibration, and causing them to vibrate in different phases The success of this device led to its trial at sea also, on a steamer of 1200 tons, but the weather was bad and the pitching and rolling of the vessel spoilt the attempt. Prof. van Iterson, Director of the Netherlands State Mines, then suggested that these disturbances might perhaps be avoided, or sufficiently reduced, by making observations on a submerged submarine instead of on a floating vessel Preliminary trials confirmed the value of this proposal and arrangements were then made for a more exhaustive test.

Dr. Vening Meinesz, who was responsible for the investigation, has recently published a provisional account of the work.[1] The apparatus (made by Stuchrath) consisted of two pairs of pendulums suspended from the same plate, oscillating in opposite phases, two by two in planes at right angles Their oscillations were recorded photographically. The pendulums were of brass, which led to difficulties in connexion with their large temperature corrections, since the temperature in a submerged submarine quickly rises; invar pendulums could not be used because of their susceptibility to magnetic fields, which are scarcely avoidable in a submarine. Dr. Meinesz suggests that errors arising from this source should be reduced in future experiments, either by the use of quartz pendulums, or by shielding the instrument from changes of temperature. The apparatus was mounted on a large wooden stand, which was not so firmly fixed as not to require watchful guard against shocks It was placed as near to the metacentre of the submarine as possible.

Successful experiments were made in the Mediterranean and in the Indian Ocean. The pendulums were swung for periods of fifteen to twenty minutes, but rather longer periods, up to thirty or forty minutes, are recommended in future work. The various sources of error are discussed by Dr. Meinesz, who concludes that the mean error of a determination of the time of oscillation of a pair of pendulums in calm weather was 2 to 3 units of 10^{-7} second, and in rough weather, with the submarine at a depth of 20 or 30 metres, about 10×10^{-7} second

This work by Dr Meinesz was recently described by Colonel Lyons at a Geophysical Meeting of the Royal Astronomical Society, and it was urged that similar work should be carried out by other countries. Sir Gerald Lenox Conyngham discussed the results obtained (in Dr. Meinesz's provisional report this is not done, nor is any chart or topographical description of the observation points given, except latitude, longitude, and the depth of the ocean) The observed values of gravity far out at sea differ sufficiently little from the computed normal values to indicate that there must be isostatic compensation. Near land the compensation seems to be less complete, and it was stated that Dr. Meinesz infers a greater extension of the compensating layer below the mainland than is required by the theory of isostasy.

[1] "Observations de Pendule sur la Mer pendant un Voyage en sous-marin de Hollande à Java, 1923." Publication Provisoire par Dr F. A. V. Meinesz.

Factors influencing Growth in Trees and Plants.

THE Carnegie Institution of Washington has recently published the results of a further very interesting series of investigations on growth in trees and massive organs of plants[1] Prof D. T. MacDougal's dendrographic measurements provide considerable additional information on the behaviour of tree-trunks. The investigations, which were conducted chiefly on conifers, but also on broad-leaved species, cover the duration of the growing season, seasonal activity, the increase of wood and of roots, the path and rate of movement of liquids in stems and the general use of the dendrometer for measuring the yearly increase in the circumference of stems. In addition, auxographic records are obtained of the growth of Opuntia stems and flowers, Mesembryanthemum leaves, potato tubers, and the fruits of Cucurbita The experiments were conducted principally on plants grown in the open and under the full influence of their habitual environment so that the normal activity of the plants was not disturbed. Amongst the interesting conclusions to which Prof. MacDougal directs attention in his summary the following may be noticed.

In the investigations on the Monterey pine (*Pinus radiata*), it is observed that the duration of seasonal growth is longest in young trees, whilst wide differences are exhibited by older trees. The thickness of the woody layer shows a general correlation to the length of the growing season but no constant relation to the total amount of rainfall; it is more likely to be due to the favourable conjunction of a number of factors in which seasonal relative humidity may be an important agent. The flow of solutions, as shown by the use of dyes, is found to be much greater late in the season than in the stage of rapid growth, and confirmation is obtained that the sap travels chiefly in the wood of the two previous years Several other interesting associations of facts in connexion with the movement of liquids and variation in girth of stem are also recorded.

In general, it is found that practically all organs or members tested with the dendrograph show daily equalising variations in size and volume in direct relation to their water-balance, and that these daily equalising variations are characteristic of each species. Further, the results of these investigations show that the amplitude of the daily variation is not dependent upon the softness of the wood and the character of the bark.

The development of potato tubers, as recorded by auxographic apparatus, shows that the period of enlargement may be estimated at 90 to 100 days, and that their behaviour is comparable to that of nuts and fruits.

The second part of the bulletin contains Dr. Forrest Shreve's records on the growth of trees. A series of

[1] "Growth in Trees and Massive Organs of Plants Dendrographic Measurements," by D T. MacDougal "The Growth Record in Trees," by Forrest Shreve (Publication 350.) Pp. 116. (Washington: Carnegie Institution, 1924) 1.50 dollars.

detailed analyses of stems of different ages and a consideration of the results obtained of growth in relation to rainfall and temperature lead to some very interesting conclusions. Examination of trunks of pine and redwood shows that the annual rate of growth is not the same at the stump and at different heights in the trunk, and that it is greater toward the centre than towards the periphery. No definite correlation is found between growth and rainfall and growth and temperature, and the conclusion drawn is that the annual growth of the specimens examined is dependent on the general complex of environmental conditions and not on any one particular factor.

A further contribution to this study has recently been published in the Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan.[1] The experiments, which took place in the University Botanic Garden at Sapporo, were conducted to show the influence of meteorological factors on the growth of trees, or, more precisely, on the girth of the trunk. Prof. Hirokichi Nakashima was fortunate in being able to select a healthy young specimen of *Abies Mayriana*, about 50 years old, which was growing a convenient distance from a meteorological station

Until recent years it was supposed that the girth of the stem increased continually from spring to autumn, and that in winter during the resting period the girth remained unaltered The experiments, however, showed that even in winter appreciable increase and diminution in girth took place, depending chiefly on meteorological factors. In fact each cycle of development may be divided into four periods During the vegetation period, from the end of April to the end of October, precipitations proved the most important factor. The relations between transpiration and absorption were the determinants through the autumnal transition period, the month of November, and the late spring period March and April During the resting period, from mid-December to the beginning of March, the temperature of the air was the chief factor. Prof. Nakashima has been able to express these relations in formulæ The conclusions drawn are that increase in girth depends either on growth or on the swelling of water-containing tissue; changes in girth are connected with transpiration and absorption; increased transpiration without corresponding water-absorption by the roots causes decrease in girth; prevention or reduction of transpiration during absorption causes swelling of the stem, and, generally, increase and decrease of girth are closely connected with meteorological conditions

The article is accompanied by the daily meteorological observations and experimental records of the whole period of five years during which the experiment lasted The apparatus used for measuring the varying size of the stem was Friedrichs Zuwachs-autograph

[1] "Über den Einfluss meteorologischer Faktoren auf den Baumzuwachs, (1) Über den Einfluss auf den Stammumfang eines Tannenbaumes," by Prof. Hirokichi Nakashima, Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan, vol 12, Part 2, p. 69. Published by the University, Sapporo, November 1924

Haddock Biology.

THE first part of a paper on the biology of the haddock, by Mr. Harold Thompson, was referred to in NATURE, August 30, 1924, p. 333. The second part, on the frequency and distribution of the age classes in 1923, which has recently been issued,[1] gives an account of later investigations. In the first part it had been shown that the year 1920 had produced a remarkably large brood of young haddock, which in 1922 were beginning to show in the commercial catches as two-year-old fish. We now learn that in 1923, as Mr. Thompson had ventured to predict, these fish had become the mainstay of the North Sea haddock market, and that they constituted 70 5 per cent. of all the haddock captured, so far as these were sampled.

The years 1921 and 1922 were both failures so far as the young brood of haddock in the North Sea was concerned, but it is pleasing to note that 1923 was one of the best years on record If all goes well with the brood, these fish should become prominent in the commercial catches in 1926 as three-year-old fish Mr. Thompson was able during 1923, by a detailed study of the scales of this group of haddock, to establish still more closely the relation between the growth of the scale and the growth of the fish He shows that the scales first formed on the fish are those which lie immediately below the third dorsal fin, and if scales from this position in older fishes are selected for examination, it will be found that the length of the fish at the end of each growth-year can be determined correctly on the assumption that the growth of the fish is directly proportional to the growth of the scale On the other hand, scales from below the second dorsal fin will give a calculated result about half a centimetre short, and those from below the pectoral fin 2 75 cm short This is an important point to have established and will clear up many of the difficulties which those working at problems of the growth-rate of fishes have encountered.

Further observations are recorded on haddock from Iceland, the Faroes, and from the Norwegian coast. The rate of growth of Iceland and Faroe haddock appears to be much greater than that of North Sea fish, but in Iceland the rate decreases from the south coast, by west and north to the east coast, where it is smallest. Good survival years for the brood at Faroe, Iceland, and Norway differ from each other and rom those of the North Sea

[1] Fishery Board for Scotland: Scientific Investigations, 1924. No. 1, Haddock Biology; No. 2, Frequency and Distribution of the Age Classes in 1923. By Harold Thompson. Pp. 48+4 plates. (Edinburgh and London: H.M. Stationery Office, 1924.) 5s. net.

University and Educational Intelligence.

ABERDEEN.—At the graduation ceremony held on April 1, the degree of D.D. was conferred on the Right Rev E W. Barnes, F R S., Bishop of Birmingham.

LONDON.—The two following courses of free public lectures at King's College are announced: "Problems of Modern Physics," Prof. W Wien, on April 21, 22, and 23; and "Recent Advances in the Study of Living Cells," Prof. R Chambers, on April 27, 28, and 29. The lecture hour in each case will be 5 30

THE Council of the University College of Southampton is to award two open exhibitions in engineering to candidates who may or may not be now resident in the district. The awards will be made on the recommendation of the Engineering Faculty Board without formal examination, provided the candidates have matriculated and are prepared to read for a degree in engineering

THREE open scholarships, each of the yearly value of 40*l*., some bursaries of 20*l*., and others covering the tuition fees in commerce are being offered in competition by University College, Leicester. The examination will be held at the College in June. Particulars may be had from the secretary.

IF industrial prospects in Great Britain are at present clouded, good progress can be recorded in

the direction of improved social service The activities of the Carnegie United Kingdom Trust, as set forth in the eleventh annual report, may be summarised as an attempt to restore to the English people the amenities of life which their forefathers enjoyed, and of which they were deprived by an over-rapid development of the factory system The library policy of the Trust has, as is well known, been directed to the provision of facilities for reading in the rural districts by the establishment of County Library schemes reinforced by Central Loan Collections Grants for the establishment of County Libraries have now been made in eighty-six counties in the United Kingdom of Great Britain and Ireland, and in the course of a few years these will all be on an independent basis The development, however, of the Central Loan Collections on self-supporting lines presents many difficulties The cost of the administration of these national book stores is likely to increase more rapidly than the income from the contributory libraries, and it is clear that in the long run some assistance will have to be provided by the State In the meantime the grant to the London Central Library has been increased from 1000*l* to 3000*l*, at which sum it will be maintained for the next four years Other activities of the Trust in the direction of fostering the national talent in musical composition, the drama, and folk-dancing continue to show satisfactory results The Margaret Carnegie Hostel for girls at Portree was officially opened last October, and a large grant has been made for the purchase of a building in East London to be used as a hostel for boys

VISUAL Education Departments in Educational Institutions form the subject of a report published in Bulletin, 1924, No 8 of the United States Bureau of Education. Of 78 State universities and State colleges, 20 have departments sufficiently well organised to employ special officials to handle visual aids. They are generally organised as parts of the university extension divisions of these institutions, but the work is not entirely extra-mural, and the departmental heads attend faculty meetings The growth of these departments is described as a teacher movement and not a commercial development on the contrary, it is a development in despite of the commercial exchanges, which have sided with the theatres in their opposition to supplying films to educational institutions Five departments undertake the actual production of films. Columbia University has a course in moving-picture production, and the University of Nebraska is said to have built a 20,000-dollar moving-picture studio on its campus. The University of Wisconsin has purchased the negatives of a large group of educational films, and sells the prints direct to other institutions at about 60 dollars per reel of 1000 feet—considerably less than what commercial firms charge The United States Department of Agriculture and the Bureau of Mines have done much to popularise instruction in agriculture and in mining and metallurgy by the use of films and slides The Bureau of Mines contrives to produce films without any expense to the Government beyond the salary of an engineer, who assists in planning and directing the work to assure its being worthy of circulation, the whole of the rest of the cost of production and making the copies being borne by the industries filmed. Colleges, high-schools, and churches are the largest users of these films. Though films figure largely in the report, they are by no means universally considered the most useful of visual aids The slide has a decisive majority vote for usefulness Much use is also made of stereographs and exhibits of objects from museums.

Early Science at Oxford.

April 13, 1686. A discourse concerning Hydraulic Engines, drawn up by Mr King of Dublin, was communicated by Mr. Ash: the Society ordered their thankes for this ingenious discourse, both to Mr Ash, and Mr. King.

Mr Caswel communicated a Mathematicall paper containing the Solutions of severall problemes, composed by Mr. Baker of Bishops Nymton in Devonshire

April 14, 1685 Mr President communicated a farther discourse concerning ye Air's Gravity observed in ye Baroscope, occasioned by that of Dr. Garden read ye last meeting He also comunicated ye following observation, that at Dover, on March 19 last past, (which was two daies after the last quarter of ye Moon) there was observed this extraordinary in ye Tide. After it had flowed some time, it ebbed two foot, then flowed again, and then ebbed, and after flowed a third time, and so a fourth time: so that there were four flowings, and three ebbings in one Tide

A Letter from Mr Cony, dated Rochester March 27, was read concerning the raining of Fish, as it was supposed to have been in that countrie some time since.—Mr Cole of Bristoll mentioned a substance proceeding from Calamy oar, which far exceeds, in colour and finenesse, all metalls, beside gold, and silver

April 15, 1684. Mr. Pulleyn informed ye Society, that an Elm, split at Cumnor, during ye late frost, was observed to have Ice in it It was affirmed that vines have been split this winter, more frequently towards ye South, than any other, point of ye compass, and that they split more in ye Thaw following ye great Frost, than in ye frost itself. ye reason of ye former may be, because vines lye most open to ye South, and partly also (as Mr Walker imagins) because ye sap-vessells are largest, and ye quantity of ye sap greatest in ye south side of ye vine, as in other Trees. Dr. Smith did himself observe, that ye Cedars of ye Physick garden, raisd from seeds brought out of Syria, bore ye shock of ye frost, without being any way damaged. Mr. Crouch was desired to enquire, whether ye Cedars of Balliol College were any way injured A Letter dated April 10th, from Mr Aston, Secretary to ye Royall Society, was read, which questioning whether a body, in shape like ye heel of a Shooe, presented by my Lord Bishop of Lincoln, to Dr. Plot, being esteemed as a Petrification of leather, be any thing more then a bare Incrustation. For ye satisfaction both of ourselves, and ye Royal Society, it was ordered, that this (supposed) Petrification should be examined, as to its make, and texture; more especially by boring it Mr. Wm Piggot tooke this charge on him.

Three papers of Dr Lister's concerning thunder &c proceeding from Pyrites, and a letter from Sir R Southwell concerning ye compasses of a Ship being changed by lightning, were read.

A Peice of black Brittish Marble, spotted white, found in ye grounds of Mr Wogan of Bolston in Pembrokeshire (who uses this sort of stone for ye makeing lime) was comunicated to ye Society, by Dr. John Floyd, Vice-chancellor of ye University. It was ordered to be put in the Ashmolean Museum. This led us to discourse of sawing marble. It was affirmed by Mr. Wheeler that Little Veins, called *pins* by ye stone-cutters, run up and down, and are sometimes so many and so hard, that they dull ye teeth of ye tooles, so that many times it is not worth ye while to worke ye stone.

Societies and Academies.

LONDON.

Royal Society, April 2.—H. E. **Armstrong**. Studies on enzyme action, xxiii. The oxidase effect and the phenomena of oxidation in general. carbonic oxide.—N. K. **Adam** and G. **Jessop**. An explanation of the so-called "intertraction phenomenon" between solutions and the molecular significance of negative surface tension. Solutions mix by sending out streamers into each other only (1) if they are superposed, and (2) if there is a difference in rate of diffusion between the dissolved substances. The streamers are due to the different rates of diffusion between the two liquids disturbing the hydrostatic equilibrium of the layers. Capillary forces are not concerned. The movements are entirely different if (1) the faster, (2) the slower, diffusing solution is superposed. With these restrictions the phenomenon seems to be general, but it involves no unknown forces. "Negative interfacial tension" means that the inward attractive forces which, when surface tension is positive, prevent molecules from escaping across the surface of the liquid, become negative. It is properly manifested in diffusion away from the body of the liquid.—Jane **Sands**. Investigation of oxidation in the blood of earthworms.—R. **Snow**. Conduction of excitation in the leaf of *Mimosa spegazzinii*. Simultaneous determinations were made of the velocities of the water current and of the excitatory conduction set up by cuts in the leaves. The latter is many times the more rapid. After the stimulus of a burn, conduction is much more rapid again. Excitation is conducted much more rapidly in the leaves of shoots totally submerged under water for several hours than in leaves attached to the plants in air. In very damp air the velocity of conduction in the leaf is increased to a less extent. Excitation is conducted down the leaf pinnæ with great acceleration, and this depends in part on the nature of the process of conduction itself. In the leaf of *M. spegazzinii*, excitation is regularly conducted by some mechanism that has nothing to do with the water current. Changes of pressure in the tube-cells play no part in conducting excitation, even in the leaf.—Dorothy **Adams**. Investigations on the crystalline lens. The lens resembles other tissues in possessing an autoxidation system made of two sulphur-containing components (*a*) water-soluble glutathione; (*b*) a thermostable protein residue. Experiments were made on fresh ox lenses, and oxygen uptake was measured directly and indirectly. Fresh lens has a definite oxygen uptake, evidently used for maintenance of its autoxidation system, since any alteration in concentration of glutathione in the lens causes corresponding change in oxygen uptake. The average glutathione content is higher than that of other more vascular tissues. The thermostable protein residue has no oxygen uptake; but with a few milligrams of glutathione it gives an oxygen-uptake curve exactly similar to that of fresh lens. Exposure of fresh ox lens to ultra-violet light or to heat rays causes measurable decrease in its glutathione content.

Royal Microscopical Society, February 18.—W. Bernard **Crow**: Variation in the hormogones of *Lyngbya nigra* Ag. The hormogones of the blue-green alga, *Lyngbya nigra* Ag., arise by division from the parent filament, the separation being effected by separation discs. Secondary separation occurs in the free hormogones, leading to the formation of very short hormogones. Some of the latter consist of a single segment only, but do not show the characters of spores. The separation discs, which are special deposits in the protoplasm, sometimes occupy a single segment. Ordinary transverse walls are occasionally absent at certain points in the trichome. Conjugations of adjacent segments in other Cyanophyceæ are interpreted as special cases of failure of transverse wall development.—W. L. **Roche**: Notes on the microscopic anatomy of the tentacular sense organ of *Cardium edule*. The siphonal tentacles of the common cockle are sensory structures, and some bear eyes and curious sense organs situated at the bases of ectodermal depressions. These "hair sense organs" occur on ocular tentacles, but may be on eyeless ones, in the former case the same nerve supplies both. These cells are club-shaped, but do not possess stiff hairs which project to the exterior. They give off fibrils which enclose the bases of the cells of the pit which themselves bear sensory hairs. This organ is probably connected with chemical sense.

Royal Microscopical Society (Industrial Applications Section), February 25.—The microscope in the textile industries. F. **Summers**. The microscope in cotton research. Two main lines of activity can be distinguished. (1) The morphological structure of the raw cotton hair itself is the object of investigation both in the natural condition and also after modification of its structure and properties by the action of chemical substances, as in various trade processes, such as mercerisation. (2) The search for the causes of the many defects—popularly known as faults—in cotton yarns and fabrics, which may be due to the presence of abnormal hairs in the raw material or to irregularities introduced during the various spinning, manufacturing, or finishing processes. The action of mildew upon cotton at every stage of manufacture is also productive of many defects, causing discolorations or, at times, actual decomposition. The study of methods for the prevention of mildew growth on cotton goods forms one of the main features of the botanical research.—T. B. **Bright**. Methods of examination of mildewed cotton material. In the majority of cases mildew is easily diagnosed, but occasionally, though the damage is considerable, there is very little fungus growth, and careful examination under the microscope is necessary.

Physical Society, February 27.—J. J. **Manley**. Notes concerning the Sprengel pump. The walls of the pump are freed from gas skins by electric means, and the shattering of the mercury pellets (which tends to liberate gas) is checked by a special construction of the fall tube.—J. **Young**. The Thomson effect in copper, iron, and carbon steels. The apparatus described by Nettleton in the Proceedings of the Physical Society, April 1922, has been employed. Different results were obtained according as the electric current in the wire under test flowed with or against the temperature gradient.—D. W. **Dye**. An improved cathode-ray tube method for the harmonic comparison of frequencies and for the delineation of their wave form. Convenient arrangements for the superposition of a telephonic and a radio-frequency displacement of the light spot of a cathode-ray tube are described. The arrangements include the following. (1) Circular or elliptical trace at a telephonic frequency to serve as a time axis; (2) radial, circular, and straight-line displacements at low radio or high audio-frequencies superposed on the circular or elliptical time trace; (3) the superposition of a long narrow elliptical time displacement and a straight-line high-frequency displacement in a direction at right angles to the major axis of the ellipse. By this means a considerable portion of the time ellipse is nearly a straight line representing a uniform time axis. The wave shape at the high

frequency then appears in normal form, and may be made of quite considerable size When an oscillatory valve system is arranged with grid and anode circuits closely coupled and harmonically resonant to each other, wave forms consisting of a fundamental and a resonant single harmonic can be produced

Linnean Society, March 5 —G C **Robson** Seriation and asymmetry in the cephalopod radula The central tooth of the radula of many Octopoda exhibits a peculiar growth-phenomenon unique among the Mollusca In the radula of *Octopus vulgaris*, for example, the ectocones in successive teeth occupy a progressively more external position, the migration from an internal to an external position usually occupying five teeth, after which a fresh ectocone appears and migrates outwards This seriation is regularly asymmetrical The asymmetry is possibly adaptational —K H **Barnard** A revision of the family Anthuridæ (Crustacea, Isopoda), with remarks on certain morphological peculiarities Twenty-four genera are recognised, of which seven are new Sixty-six species are diagnosed, of which twenty-one are described for the first time Particular attention is given to the occurrence of paired and unpaired statocysts and to the arrangement of the parts forming the tail-fan —E Marsden **Jones** The pollination of *Primula vulgaris* Fifteen species of insects were seen visiting the flowers Of these, six have a proboscis long enough to pollinate satisfactorily and appear to be adequate to effect pollination Bombylius especially was found visiting consistently and almost exclusively the primrose No night visitors were seen The plants examined showed a good record of seed production, while two plants under control, a long and a short styled form, failed to produce a single capsule It therefore seems that insect agency is necessary to secure pollination

EDINBURGH

Royal Society, March 9 —A H R **Goldie** Discontinuities in the atmosphere The origin of "inversions" of temperature and discontinuities of motion in the atmosphere, and the dynamics of waves at a surface of discontinuity, are discussed, events are supposed to take place under adiabatic conditions It is suggested that continuous ground level records may provide a means of estimating upper air structure The effects of rotation of the earth on the wave motions are dealt with mathematically, and the results are in fair agreement with actual values taken from autographic records —A P **Laurie** Stone decay and preservation of buildings The principal cause of rapid decay of stone is the crystallisation of calcium sulphate within the stone. The pollution of air by sulphur dioxide extends to remote regions in the country, and in the case of silicious sandstones, pollution of the stone with lime dissolved out of the mortar or cement acts as a trap for the sulphur acids Anything in the nature of a skin over the surface of the stone like cement or plaster of Paris acts like an osmotic diaphragm, allowing free evaporation of water but causing a crystallisation pressure within the stone Thus the length of life of limestone buildings will probably be increased by periodical washing in the summer Stones should be selected for their resistance to acid attack and the rapidity with which they absorb and lose water.—W. H. **Watson** An investigation of the absorption of superposed X-radiations Two beams of X-rays transmitted in different directions through aluminium do not suffer any change in absorption as a result of superposition This holds when both beams experience the J transformation by transmission. No information could be obtained for the case where only one beam is so transformed. The incidence of a hard primary beam on silver which is absorbing a beam of the characteristic radiation of K series of that element does not influence the absorption of the latter beam in the manner expected in terms of C T R Wilson's conclusions from β-ray photographs —H S **Allen** Note on Whittaker's quantum mechanism — H W **Turnbull** and J **Williamson** The minimum system of two quadratic forms A strictly irreducible system of projective invariants of two quadratics and any number of linear forms consists of $3n+1$ members, where n is the number of homogeneous variables involved The number of algebraically independent invariants is $3n$ —Marion C **Gray** The equation of the conduction of heat. The problem of the conduction of heat depends on the solution of a second order partial differential equation of parabolic type Various general solutions of this equation have been given, notably by Fourier, Forsyth, and Poincaré The apparently different general solutions can be derived from one another

PARIS

Academy of Sciences, February 23 —Ch **Moureu** The destruction of the original calorimetric bomb of Berthelot Its replacement by a bomb of a new type — Georges **Giraud** The generalised problem of Dirichlet, non-linear equations with m variables — Gaston **Julia** Series of rational fractions of iteration —N **Abramesco** The curves of convergence of series proceeding according to the inverse of given polynomials —*Léon* **Pomey** The theorem of the existence of solutions of linear partial integro-differential equations —Georges **Valiron** An integral function of zero order which is a solution of an algebraical differential equation —**Jarry-Desloges** Contribution to the study of the phenomena of the surface of the moon —**Ferrier** and L **Besnerais** A new law of electromagnetism Admitting that two electrified particles exert on each other actions of equal and opposite magnitude $d\mathrm{W}/dr$ with $\mathrm{W}=e^2\mathrm{F}(u, \ldots)/r$, it is possible to conceive the existence of an electric ether constituted uniquely by particles of the same sign. This formula can interpret, not only the known phenomena of electromagnetism, but also certain hitherto unexplained facts in the field of radio-activity —B **Szilard**. A method of comparison permitting the measurement of extremely small currents. A detailed description, with diagram, of a method of measuring very small ionisation currents of the order of 1 U E S with an absolute error of $1/10^5$ U E S unit —François **Liana** The transparency of glasses in the infra-red Fifteen kinds of glass have been studied in the infra-red spectrograph of Moll For a thickness of 15 mm and for radiations of wave-length higher than $3{\cdot}2\mu$, all the glasses were found to be practically opaque The glass which has been found the best as regards transparency and dispersion is the flint D/262 —Nicolas **Perrakis** Trouton's quotient at the absolute zero of temperature Trouton's ratio tends to a finite limit as the temperature approaches the absolute zero —Francis **Perrin** The theory of polarised fluorescence. The influence of the viscosity. —Fred **Vlès**: The spectrophotometric measurement of P_H. A formula is derived by means of which the hydrogen ion concentration can be obtained as a function of the ratio of the absorptions, independently of the concentration of the indicator and without a preliminary empirical standardisation —G **Athanasiu**: The sensibility of actinometers with mercury electrodes —A. **Wahl** and Th. **Faivret**: The derivatives of methyl-7-isatin.—Jovan **Cvijic**: Morphological types of calcareous strata.—Jean **Lugeon**: The relations

between various meteorological discontinuities and the atmospherics in the neighbourhood of mountain chains Atmospherics differ considerably on the plain, in valleys, and on high mountains There appears to be a direct relation between the electrical state and the weather present over the whole of the Alps and the Jura —L **Petitjean** A stationary discontinuity in the western Mediterranean —H. **Colin** and A **Grandsire** The structure and chemical processes in the beet-root — Henri Jean **Frossard** The production of the voice —H **Violle** and L. de **Saint-Rat** The hæmostatic properties of pectin —Ed **Bayle** and René **Fabre**. Study of the urinary elimination of alkaloids derived from isoquinoline and especially hydrastine A small proportion, about 3 per cent, of the hydrastine absorbed is eliminated with the urine — E **Fauré-Fremiet** and Boris **Ephrussi** The action of temperature on the movement of translation of *Arcella vulgaris* —Robert **Weill** The skeletonisation of the nematocysts of the Cœlenterata —Maurice **Piettre** A new process of metabolism of the reserve fats Butyrisation outside the breast —E **Marchoux** The action of arsenic on the malaria due to *P. vivax* Stovarsol (acetylaminophenylarsenic acid) administered either by the mouth or by injection has a rapid action on *P. vivax*, causing its disappearance, but *P. malariæ* and *P. falciparum* are unaffected by this drug This is evidence against the view that there is only a single parasite, capable of undergoing morphological and biological variations according to circumstances.

SYDNEY

Royal Society of New South Wales, December 3 — Griffith **Taylor** and F **Jardine** Kamilaroi and white; a study of racial mixture in New South Wales The work was carried out chiefly upon aboriginals of the Kamilaroi tribe and their hybrids with the whites The tribe occupies the central-north New South Wales. Fifty individuals were measured and details of their castes, hair, eyes, skin colour, etc., were obtained 19 full-bloods, 7 three-quarter-castes, and 6 half-castes are discussed among the adults, and about a dozen children The variation of cephalic index with influx of white blood is not noteworthy and does not appear in the frequency curves The face index, however, shows a broadening in this respect The nasal index frequency curves indicate influx of white blood very clearly, the half-castes being much more leptorhine. The hair is wavy to curly among the full-bloods, *i.e.* not very different from the hair of white folk True curly hair was only noticed once The eyes are usually muddy brown, sometimes with a narrow, slate-blue margin The skin colour (under arm) is rarely chocolate, usually red-brown in the full-blood men, and Indian red in the women. It changes fairly regularly through yellow-brown to ochre with larger proportions of white blood —R. H. **Cambage** Acacia seedlings, Pt. X Seeds of *Acacia podalyriæfolia* and *A. melanoxylon* have germinated after having been immersed in sea-water for five and seven and a half years respectively, the latter case being regarded as a record for the experiment Certain of the species of Acacia which flower in midsummer take about one year to ripen their pods, while those flowering in the very early spring commonly have mature pods in four or five months — A. R. **Penfold**: The essential oil of *Boronia safrolifera* This recently named species of pinnate leaf Boronia grows in the swampy portions of the heath country around Broadwater, Richmond River, N.S.W. The leaves and terminal branchlets yielded 1·45 per cent. of a pale yellow oil heavier than water, highly refracting, and possessing an odour of its principal constituent, safrol, which was present to the extent of 70-75 per cent The other constituents are d-a-pinene, methyl eugenol, with minor quantities of a phenol and paraffin The oil possessed the following constants Specific gravity, 15/15° C., 1·034, optical rotation, +3·79°, refractive index, 20° C., 1·5180 —F. R. **Morrison** A chemical examination of the seeds of the "Bunya Bunya" (*Araucaria Bidwillii*) Part I The tree is one of the Queensland pines, and bears annually cones containing more than 100 seeds The kernel constitutes 77 per cent of the seed The composition of the air-dried powdered kernel was determined as follows Fat 2·6 per cent., dextrin 7·72 per cent., starch 65·83 per cent., crude fibre 7·93 per cent., moisture 13·82 per cent., ash 2·1 per cent Microscopically, the starch resembles rice or maize starch —M. B. **Welch** A further contribution to the knowledge of the silky oaks The anatomical structure of a number of timbers belonging to the natural order Proteaceæ, and often known as silky oaks, was described The woods are characterised principally by their large multiseriate rays —W. R. **Browne** Notes on the petrology of the Prospect intrusion The mode of occurrence of analcite and other zeolites in the intrusion as well as chlorite, serpentine, and calcite, is discussed, and reasons are given for regarding them as due to late-magmatic or deuteric processes The rock composing the intrusion should be called an olivine-analcite-dolerite rather than an essexite

MELBOURNE.

Royal Society of Victoria, December 11 — T. H. **Laby** and Miss **Nelson** The thermal conductivity of gases a contribution to the International Critical Tables A description is given of the method by which the values of the conductivity contained in the tables are arrived at from the determinations available A weighted mean is taken For air the results of different observers are so weighted that equal weight is given to the methods—cooling thermometer, hot wire, and plate method—which have been used to determine the conductivity of gases The temperature variation of conductivity of a number of gases is expressed by means of Sutherland's formula —T. H. **Laby** and E. O. **Hercus** Experiments on the mechanical equivalent of heat made with the apparatus described in NATURE, June 30, 1923 The value of the 20° C. calorie is higher than the usually accepted value 4·180 (or 4·181) × 10⁷ erg. A recalculation of the indirect electrical experiments of Callendar and Barnes, Griffiths, Jaeger and Steinwehr, allowing for the departure of the electrical units used by these observers from their probable C.G.S. values, gives a mean of 4·183 × 10⁷ erg per 20° calorie —W. J. **Young** and J. R. **Vickery** The changes which take place during the freezing of beef for export Alterations in the microscopic structure produced by freezing at three different rates were compared by cutting sections while the meat was still frozen, and examining under the microscope in a room well below the freezing point. The freezing methods used were liquid air, brine at −15° C., and air at −15° C., the times of freezing being almost instantaneous, 2·5 and 15 hours respectively The section frozen in liquid air presented a homogeneous granular appearance; the other two contained large crystals of ice between the muscle fibres, many of the latter being twisted and broken in the process The difference was much more marked in the sample frozen most slowly The changes occurring in the refrigeration of beef occur in the actual freezing —Miss **Kerr**: The symbiosis of Loranthus and Eucalyptus. For a time at least a

Eucalyptus stock which has no foliage of its own can be nourished by a parasitic Loranthus, *i.e.* that a relationship may be established analogous to that between the stock and scion in a grafted plant. The injurious effect upon the host plant is due to the excessive transpiration rate of the parasite, which causes the host plant to suffer from lack of water, particularly during dry periods.—G. F. Hill. Termites from the Australian region: descriptions of new species and hitherto undescribed castes. Eight species are proposed as new, including two species of Eutermes from W. Australia and one species each from N. Queensland and N. Territory, one species of Calotermes each from Victoria and N. Territory, and two from Lord Howe Island. The alate imagos of two species of W. Australian Eutermes, hitherto known in the sterile castes only, and the soldier caste of two species of Calotermes (from Victoria and W. Australia respectively), hitherto known in the alate form only, are described for the first time. One of the latter, *C. obscurus* (Walker), until recently known only from the badly-damaged type and a very inadequate description, has been re-discovered in the type locality and fully described. A new name (*C. rufinotum*) is proposed for the Victorian species previously described in detail and provisionally referred to the last-mentioned species by the writer.—J. A. Smith. The graduation of the circle. Early graduations by hand, and the ingenious steps in the evolution of the "graduating engine" were outlined. The design and construction of modern machines such as the Swasey were described. The attainable precision is of the order of a maximum deviation of one-tenth of an inch at one mile.

VIENNA

Academy of Sciences, February 5.—Scientific results of the expedition to the Anglo-Egyptian Sudan (Kordofan) undertaken by F. Werner in the year 1914. XXI.—I. **Sjostedt**: Isoptera, reporting two new kinds of termites, with an appendix by R. **Ebner** on termite buildings. XXII.—W. **Adensamer**: Mollusca, including those of the Blue Nile.—H. **Pettersson**: Communication from the Radium Institute, No. 176. Theory of the method of atomic disintegration. A simple arrangement is described which enables the H-particles and reflected α-particles from disintegrated elements to be observed when weak radium C or thorium C preparations are used. The use of this arrangement for observing the number of H-particles emitted simultaneously by a disintegrated nucleus is shown by a series of measurements with aluminium.—H. **Handel-Mazzetti**: Plantæ novæ Sinenses. Thirty-second contribution, including three new species of Lysimachia.—A. **Köhler**: The granulite and granulite-gneiss problem in the south-western forest quarter of Lower Austria near Säusenstein, Wieselburg and Melk.—O. **Wettstein**: A new species of mouse from Lower Austria.—R. **Andreasch**: On carbamide and guanidine derivatives of the sulpho-fatty acids.—O. **Lehmann**: The geographical results of Dr. H. Handel-Mazzetti's journey through Guidschau (Kweitschou) in South-Western China.

Official Publications Received.

Department of the Interior. Bureau of Education. Bulletin, 1924, No. 32: A Study of 260 School Consolidations. By J. F. Abel. Pp. iv+39. 10 cents. Bulletin, 1924, No. 29: Legislation on the Junior High School. By Paul W. Terry and William J. Marquis. Pp. iii+42. 10 cents. Bulletin, 1925, No. 1: Educational Directory, 1925. Pp. iii+201. 25 cents. Bulletin, 1924, No. 28. Fiscal Support of State Universities and State Colleges. By Dr. Clarence Howe Thurber. Pp. iv+164. 20 cents. Bulletin, 1924, No. 30. A Manual of Educational Legislation, for the Guidance of Committees on Education in the State Legislatures. Pp. iii+51. 10 cents. (Washington: Government Printing Office.)

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, the Physiological Chemist, and the Secretary, Sugar Bureau), 1923-24. Pp. iv+141. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s. 8d.

Report of the Department of Mines for the Fiscal Year ending March 31, 1924. Pp. iii+71. (Ottawa: F. A. Acland.) 15 cents.

Canada. Department of Mines. Geological Survey. Memoir 142, No. 138 Geological Series: Preliminary Report on the Clay and Shale Deposits of Ontario. By J. Keele. Pp. iii+176+9 plates. 25 cents. Summary Report, 1923, Part B. Pp. 115B. Summary Report, 1923, Part C1. Pp. 168C1. Summary Report, 1923, Part C2. Pp. 44C2. (Ottawa: F. A. Acland.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 14. Spectroscopic Evidence of Isotopy. By H. Nagaoka, Y. Sugiura and T. Mishima. Pp. 112. 1 yen. No. 15: The Results of the Analyses of the Soils and the Ashes of some Sugar Cane. By I. Wada, S. Ato and S. Kato. Pp. 113-124. 20 sen. No. 16: Application of X-ray Diffraction to the Determination of the Transformation Temperature of Thallium. By G. Asahara. Pp. 125-137+2 plates. 40 sen. No. 17. Distribution of Electric Field in Metal Arcs and the Stark Effect observed in Arcs of Silver, Copper, Magnesium, Chromium, Nickel, Cobalt, Iron and ten other Metals. By H. Nagaoka and Y. Sugiura. Pp. 139-167+plates 8-17. 250 sen. No. 18. Spectrum of Mercury under heavy Current Excitation. By M. Fukuda. Pp. 169-183+plates 18-20. 60 sen. (Komagome, Hongo, Tokyo.)

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circonstance, No. 85. Observations on the Witch (*Pleuronectes cynoglossus* L.) and its Growth. By Arvid R. Molander. Pp. 15. (Copenhague: Andr. Fred. Høst et fils.)

The National Physical Laboratory. Report for the Year 1924. (Published for the Department of Scientific and Industrial Research.) Pp. 221. (London: H.M. Stationery Office.) 8s. 6d. net.

British Research Association for the Woollen and Worsted Industries. Annual Report, 1924. Pp. 19. (Headingley, Leeds.)

Proceedings of the University of Durham Philosophical Society. Vol. 7, Part 1, 1923-1924. Pp. 58. (Newcastle-on-Tyne.) 5s.

University Ideals. the Presidential Address to the Yorkshire Natural Science Association, Session 1924-25. Genetics and Wool Production: an Address to the Pan-Pacific Science Congress held at Sydney University, August 1923. By Prof. Aldred F. Barker. Pp. iv+60. (Leeds.) 5s.

Diary of Societies.

TUESDAY, APRIL 14

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub Centre) (at Loughborough College, Loughborough), at 6.45.—A. B. Mallinson and others: Discussion on Justifiable Small Power Plants.

WEDNESDAY, APRIL 15

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates' Meeting) (at Chamber of Commerce, Birmingham), at 7.30.—A. Weatherstone: High speed Motor cycle Engine Valve Gears.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—Dr. F. S. Goucher: The Strength of Metals at High Temperatures.

THURSDAY, APRIL 16

INSTITUTE OF CHEMISTRY (Belfast Section) (at the Queen's University, Belfast), at 7.30.—Prof. Symmers: Address.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—C. H. M. Jenkins: Metals in the Gaseous State.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—J. Guild: The Geometrical Solution of Colour Mixture Problems.—Peeling and Van Neck: Exhibition and Description of The Hahn-Goerz Workshop Microscope, The "Artisol" Mirror Arc Lamp.

FRIDAY, APRIL 17

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street, W.1), at 3.30.—J. L. Chaloner: Recent Oil engine Developments.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Dr. H. D'Arcy Power: The Reproduction of Colour and Tone.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. T. Dunn: Vertical Retorts.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—Question Night.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Sir Henry Gauvain: The Organisation and Work of a Light Department in a Surgical Tuberculosis Hospital.—Dr. G. Murray Levick: The Selection of Apparatus for the Production of Artificial Sunlight.—Prof. Russ and Dr. Peacock: Ultra-violet Radiation.

SATURDAY, APRIL 18.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Municipal College of Technology, Manchester), at 7.—A. Hill: Foundry Materials.

BOLTON AND DISTRICT MANAGERS' AND OVERLOOKERS' ASSOCIATION (at the Institute, Henry Street, Bolton), at 7.30.—B. Robinson: Education and Industry.



SATURDAY, APRIL 18, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2894, VOL. 115]

The Universities and International Relations.[1]

IN the United States, the Government takes no part in the promotion of international interchanges of students and teachers, except in a negative sense—through the application of the laws restricting the immigration of aliens; but several powerful corporations do very energetically encourage such interchanges. The activities of the American University Union in Europe (London and Paris) and the American Council on Education, in which the Union is now merged, are well known. The Council's *Educational Record* of April gives particulars of 76 American organisations in the field of international educational relations. One of these, the Institute of International Education, founded in 1919, administers a large number of scholarships for students of various nationalities, makes grants for expenses of foreign travel to American professors on leave of absence, publishes guide-books for foreign students in the United States and for American students in foreign countries, holds educational conferences, and serves as a clearing-house for information relating to international education. It has, moreover, fostered the formation of clubs for the discussion of international relations in American universities.

The Rockefeller Foundation devotes vast sums to the endowment, largely by means of international fellowships and grants to foreign universities, of study and research in medicine and hygiene. "International House," opened in 1924 in New York as a residential club to accommodate 500 students from all parts of the world, was built by Mr. J. D. Rockefeller, Jun. This philanthropist founded in 1923 an "International Education Board," which has established the International Institute of Teachers College, Columbia University, and endowed it with an annual grant of 100,000 dollars a year for ten years. The work of this institute comprises the exposition of American ideals and institutions as a basis for understanding American education, instruction in American systems of pedagogy and their adaptation to foreign situations and problems, and visitation of American schools. In 1923, some 250 foreign students were availing themselves of these facilities for "becoming intellectual subjects" of America, and there were also in attendance 100 Americans who held posts as teachers in other countries. Other appropriations of the International Education Board, amounting in all, up to June 30, 1924, to more than six hundred thousand dollars, include 60 science fellowships for workers in 17 countries.

In 1921 the number of foreign students in United States colleges and universities was 8357. In the same

[1] Continued from p. 523.

year, the universities of Germany, which, before the War, had more than those of any other country, had 6334. This, considering the troubled condition of the country, is a surprisingly large figure. The close relations formerly existing between German and American universities have not yet been restored, but steps in this direction have been taken. The International Institute of the University of Heidelberg for the study of English and American institutions has on its advisory council eleven eminent representatives, including several presidents, of American universities; it invited the Director of the Institute of International Education to be the council's chairman

The American Commission for Relief in Belgium was responsible for founding in 1920 the Fondation Universitaire in Brussels with a capital of 55 million francs. This foundation, in addition to its other activities, makes grants for study in American universities to Belgian graduates and vice versa, and arranges exchange visits of professors. The American-Scandinavian Foundation provides 40 travelling fellowships of a thousand dollars each for travel and study by American graduates in Scandinavian universities and vice versa In Spain, the oversight and direction of all matters relating to State scholarships tenable abroad, exchanges of teachers and students, bursaries in connexion therewith, and courses for foreign students, are entrusted to the Junta para Ampliación de Estudios e Investigaciónes Cientificas. This body has established a Spanish Institute in New York, which is housed in the offices of the Institute of International Education.

In Great Britain and Ireland the international interchange of university students and teachers is encouraged neither by the State as in France, Italy, and Spain, nor, with the exception of the Rhodes Scholarship Trust, by great corporations as in the United States. There are, however, a number of travelling fellowships and scholarships established in connexion with some of the universities, and since 1922 the National Union of Students of the universities and university colleges of England and Wales has been active in promoting foreign travel of English students and their intercourse with students abroad.

It is sometimes assumed that international interchange of students must necessarily tend to promote international amity through dissipating prejudices and misconceptions, but it is by no means always the case that the impress on the mind of the university student of the contacts he makes when sojourning in a foreign university has this desirable tendency. The same may be said of the impressions produced by university students and teachers visiting foreign institutions. Quality is all-important, and measures undertaken for the indiscriminate multiplication of interchanges may do much harm to the cause their authors wish to promote. This principle was fully recognised in the framing of the Rhodes scholarships scheme and its new American counterparts, and it should never be lost sight of by those whose duty it is to award scholarships tenable in foreign countries

It is, on the other hand, important that the visitors should have sufficient opportunities of participating fully in the social as well as the academic life of the university. To those who fulfil its matriculation requirements, the university opens its doors and thenceforward treats them all alike without respect to race, creed, or nationality. The ordinary matriculation requirements are, moreover, relaxed in favour of students who, having been educated abroad, are not prepared to pass the ordinary English matriculation examinations, but have qualified for admission to a foreign university. For the university to show still further solicitude for the interests of foreign students as such by making special provision for their social well-being would be inappropriate and liable to misconstruction. Their special needs, however, have been made the subject of sympathetic consideration by several bodies not officially connected with the universities, notably the Student Christian Movement, the National Union of Students, and the League of Nations Union.

In relation to such matters as the provision of opportunities for social intercourse, obtaining suitable accommodation in term and during vacations, the help afforded to foreign students by these bodies is of great value. Discussions promoted by the National Union of Students have stimulated among student bodies an increasing interest in international relations: an interest which has led to the formation of "Hospitality Committees," which have invited parties of about half-a-dozen students of universities in Germany, France, Czecho-Slovakia, Denmark, and Norway to visit English universities during term. As a rule, one party is invited each term. On arrival the visitors become the guests of English student organisations, thus being saved all expense of board and lodging, and are given an intimate view of English life in the universities; in some cases even railway travelling expenses have been borne by hosts. The period of stay in each university varies from three to ten days. Universities that have already entertained in this way are Cambridge, Oxford, London, Liverpool, Birmingham, and Leeds. To some extent these visits are of a reciprocal character, student bodies in foreign universities offering similar hospitality to parties of English students, but there is nothing in the shape of bartering in connexion with them, the invitations being in every instance free, unconditional, and spontaneous, and actuated by a desire to promote good feeling between the nations.

Finally, mention must be made of certain organisations which are international not only in their activity, like the bodies already mentioned, but also in their constitution: The Committee on Intellectual Co-operation of the League of Nations, with its University Information Office; the Confédération Internationale des Étudiants, formed at Strasbourg in 1919; the International Federation of University Women, founded in 1920; and the World's Student Christian Federation. All these in different ways work for international harmony through improved mutual understanding, and cultivate a certain detachment from the national point of view and a spirit of mutual toleration, which are indispensable preliminaries for co-operation. Education is, no doubt, a peculiarly favourable field for international co-operation in certain conditions; for example, there is now a valuable opportunity for co-operation between Great Britain and China; but to what extent internationally constituted bodies are suitable instruments for organising such co-operation is doubtful. Owing to the diversity of their constituents, they are likely to be less effective in some respects than national bodies such as the American Institute of International Education.

Recent Atomic Theory.

(1) *The Theory of Spectra and Atomic Constitution: Three Essays.* By Prof. Niels Bohr. Second edition. Pp. x+138. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

(2) *Vorlesungen uber Atommechanik.* Von Prof. Dr. Max Born. Herausgegeben unter Mitwirkung von Dr. Friedrich Hund. (Struktur der Materie in Einzeldarstellungen, 2.) Erster Band. Pp. ix+358. (Berlin: Julius Springer, 1925.) 15 gold marks.

(3) *Zeemaneffekt und Multiplettstruktur der Spektrallinien.* Von Dr. E. Back und Prof. Dr. A. Landé. (Struktur der Materie in Einzeldarstellungen, 1.) Pp. xii+213+2 Tafeln. (Berlin: Julius Springer, 1925.) 14·40 gold marks.

THE structure of the atom will be generally admitted to provide the most fruitful and important field of work in modern physics, but even so it can be but rarely necessary to welcome simultaneously three books of such importance dealing with this one subject. Let us extend to the three at once the warmest possible welcome, and proceed to consider separately their individual contents, and the light that they throw on the recent trend of speculation in atomic theory.

(1) It is convenient to consider first the reprint of Prof. Bohr's three essays, to which, in this edition, an appendix has been added describing shortly later developments which correct and amplify certain earlier statements, particularly in the third essay. The theme of this whole book may be called the "central orbit" theory of the atom, originated by Prof. Bohr, and developed largely by Prof. Sommerfeld and himself. The theory sets out to co-ordinate the main features of atomic structure, spectra, and other properties on the basis of a classification of the orbits of the electrons in the atom into groups, specified by the two quantum numbers n and k, which must characterise any orbit in a conservative central field of force, not obeying the law of the inverse square. Purely electrostatic forces must still give rise, by a screening effect, to such deviations from the inverse square The success of this theory is now a commonplace The development of any significant theory consists of two parts of equal importance—the determination of the field of facts which the theory can successfully correlate, and the determination of the field of facts which, by their very nature, must lie outside the domain of the theory In the case of the central orbit theory, as these essays and their appendix now make abundantly clear, these domains are already well defined The dividing line lies at that point at which it is necessary to introduce a third quantum number to account for optical and X-ray ("relativisitic") doublets. Questions such as these are essentially connected with the interactions between one electron and others in an atom Bound up with them are all the questions connected with the closing of electronic groups and sub-groups, the numbers of electrons in these groups, chemical combinations (other than of ionic type), and the insistent manifestations of half-quantum numbers These matters lie necessarily outside the domain of the central orbit theory, and the modification of theory necessary to meet them is not yet clear It is clear only that it must be fundamental.

Great progress has already been made in this wider domain, thanks largely to the study of the Zeeman effect and its partial but strikingly successful interpretation in terms of a magnetically coupled system of core and series electron. But this is not enough. These, however, are matters deliberately excluded from Prof. Bohr's book, for which we may naturally turn to Profs. Back and Landé. In the field proper to the central orbit theory, its success has been singularly rapid and complete. Quantum numbers n and k can be specified with certainty for all electronic groups and all (or nearly all) X-ray and optical terms (in the simpler spectra), and the general features and properties of the atom are convincingly represented. There remain only many interesting points of detail, especially in the assignment of quantum numbers for certain optical

terms; but these may, of course, prove to be of unexpected theoretical significance.

If this interpretation of the situation is correct, and we may write *Finis* to the central orbit theory, a superficial feeling of disappointment is perhaps inevitable, but still more certainly unjust Every valuable theory in process of development must raise hopes that are naturally extravagant. We have only to contemplate for a moment the successes of the theory, and the beautiful correlations it has introduced into such a wide range of physical and chemical properties—to read once again Prof. Bohr's book—to lose all feelings of disappointment, and rest convinced that the theory, like the nuclear theory from which it springs, will remain a fundamental link in the chain of physical science.

(2) The other two books to be noticed here are the first two volumes of a series of monographs, of which the general title is "Die Struktur der Materie," and the general editors Profs. Born and Franck, of Gottingen. The field of atomic physics is being developed at such a pace in so many directions that it is scarcely possible any longer to cover the whole ground in a single treatise. The outstanding attempt so to cover the ground is Prof. Sommerfeld's monumental book. This has grown from 570 to 860 pages in four editions. Even so it cannot discuss fully many important questions. While it remains perhaps the best general introduction to the whole subject, detailed presentations of separate branches, in particular of the mathematical foundations, are also required, and it is to provide these that the present series has been started. The need is admittedly urgent and these two volumes are worthy of the occasion. Let us hope that they will be speedily followed by worthy successors.

Prof. Born's book on atom mechanics is a book for which there has been a peculiarly urgent need, for it should provide just that introduction to atomic theory which a mathematical student requires, presented in the mathematical form which he will most appreciate. There is no such book in English, or, previously, in any other language; one may venture to hope that it will be shortly published in an English translation, for unless some similar book is written in English, Prof. Born's should be freely used by students to many of whom the language must prove a difficulty. The matter presented in this book is the mathematical structure of the present form of the quantum theory and its applications. It may fairly be described as an almost ideal mathematical companion volume to Prof. Bohr's writings on the central orbit theory. Questions outside the field of this theory are deliberately excluded. In view of these well defined limitations, Prof. Born calls his book "Volume 1." By this he explains that he wishes to emphasise these limitations, and hopes to write some day in Volume 2 the next approximation to the true mechanics of the atom.

Perhaps the best part of the book is Chapts. i. and ii., which develop, with exquisite attention to the finer points, the Hamilton-Jacobi theory and the formal quantum theory of periodic and multiply-periodic systems. The fourth and last chapter gives an account of perturbation theory, with (condensed) applications in particular to the helium problem, which it is most convenient to have in this form. It is true that the applications of the theory have been largely negative, but they have, as Prof. Born says, sufficed to show that it is not the purely analytical difficulties of the n-body problem which conceal from us the details of atomic structure, but difficulties of an entirely different order. Negative or not, this is a theoretical point of fundamental importance. The remaining Chapt., iii., is entitled "Systems with One Series Electron." It might with advantage have been divided into two chapters, one on the general theory of the hydrogen-like atom, the other on the series formula of Rydberg and Ritz. The section on the hydrogen atom gives a systematic account of all the theoretical work on this atom, in which the modern formulation of the quantum conditions and the requirements of the correspondence principle are kept constantly in view. Systematic applications of the theory of secular perturbations are made at every stage. One is particularly thankful to find here an easily followed exposition of the difficult problem of the crossed electric and magnetic fields, after the elegant method of Lenz and Klein.

The remaining section on the Rydberg-Ritz formula is an important part of the book, for the theory of this formula is one of the great successes of the present theory, and, in a sense, the basis of Prof. Bohr's general scheme of atomic structure. The account here given is different in viewpoint to that of Prof. Sommerfeld (Ed. 4), being deliberately more theoretical. It contains, too, the first published proof of Prof. Bohr's general theorem on the Rydberg-Ritz formula [When will Prof. Bohr publish his own still more elegant account?], and an account of Prof. Born's own work with Heisenberg on the polarisability of the core. It culminates in an account of the determination of the principal quantum numbers of optical terms, leading on to a general survey of the periodic system. It must be admitted that it is possible to criticise this section on points of detail, but the theory is here least fully formed. It forms as a whole a most valuable contribution to the literature of the subject.

(3) In the remaining book, by Profs. Back and Landé, on multiplet structure and the anomalous Zeeman effect, we pass, as we have already said, right beyond

the limits of the central orbit theory. To the theoretical exploration of this field no one has contributed more than Prof. Landé himself. It is perhaps fair to say that his (the theoretical) section of the book is scarcely a new systematic exposition of the present position of theory in this field, but rather reminiscent of a collection of reprints of his own and others' papers on these subjects. It is therefore sometimes a little hard to be sure whether a statement is to be regarded as a statement of fact, a deduction from generalised theory, or from some specialised model. This perhaps is inevitable and certainly extremely difficult to avoid at such a stage of development as the present. It is a great thing merely to have the work collected in this readily accessible form, especially the suggestive speculations on multiplet spectra of the second rank. The book should serve to stimulate further advances in this field, which will almost certainly be of dominant importance in the next development of atomic theory. The experimental (Prof. Back's) section of the book appears to a layman to be an excellent systematic account of the experimental side of the determination of anomalous Zeeman types. This is not without its special difficulties when the type is a complicated one. A septett (df) line may split into as many as 33 components at $\frac{1}{10}$ the normal separation, with a very large range in intensity. These difficulties are carefully treated, and there are numbers of extremely useful tables and diagrammatic representations of types. The book ends with a plate of 35 beautiful photographs. These alone almost reconcile one to its price. R. H. Fowler.

Science for the Public.

Chats on Science. By Dr. Edwin E. Slosson. Pp. vii+253. (London: G. Bell and Sons, Ltd., 1924.) 6*s*. net.

Keeping up with Science; Notes on recent Progress in the various Sciences for Unscientific Readers. Edited by Dr. Edwin E. Slosson. Pp. xv+355+30 plates. (London: Jonathan Cape, Ltd., 1924.) 10*s*. 6*d*. net.

THE popularisation of science has been frequently discussed in the columns of Nature, and the subject is undoubtedly arousing increased attention. In the daily press there is evidence of a desire to devote more attention to science; and some of the leading dailies endeavour to secure that what they print is really authentic. On the whole, however, the position is far from satisfactory, and in those cases where the serving up of science is left entirely to the ordinary journalist in search of stirring news, the result is often very deplorable. A newspaper that would think it discreditable to commit a solecism in dealing with any other branch of knowledge, or with such special matters as music and painting, is often found capable of printing the most egregious paragraphs in relation to science.

The British scientific world constantly demurs to this treatment by the press, yet does little to help in bringing about a more satisfactory state of things. Certainly it is difficult to know what to do or to recommend. Some people go so far as to affirm that it is not possible to do anything at all with the physical sciences. "You can count," they say, "on no knowledge even of the most elementary kind in the minds of your newspaper readers; how can you expound new discoveries when on every occasion you have to go back to the very alphabet of science as your starting point?" The answer is, no doubt, that while very much cannot be done, something may be done, and that it is desirable for the scientific world to help in making that something as good as possible.

It is important to recognise the difference between knowing science and knowing about science, for the present-day demand, which the circumstances of our disordered world have greatly intensified, seems to be, above all, for a better knowledge about the ways of science. Scientific men are beset to-day by eager inquirers who want to know what is the real incidence of science upon thought and life, how much it can contribute to right thinking and right living, how far it embodies an element of the spiritual. How is it possible to respond at all effectively to this demand?

It is with this question in our mind that we take up with interest the two books before us from the hand of the Director of Science Service, Washington. The Science Service was founded by private enterprise in 1921. "The Institution was intended to serve as a liaison officer between scientific circles and the outlying public . . . and it has been doing what it could to spread a knowledge of scientific achievement and ideals by means of newspapers, magazines, books, and motion pictures." It has been warmly encouraged by American men of science, it has a large staff and, we understand, a thoroughly well-organised system of providing the press with trustworthy scientific news and other scientific copy in an acceptable form.

Of the books under notice, that entitled "Keeping up with Science" consists mainly of articles which have formed a fortnightly page in the *Country Gentleman*. The other book is exactly what its title states—"Chats on Science," each occupying two or three pages that can be read in as many minutes. In neither book is there any ordered sequence or continuity of topics; indeed, the design seems to aim at quick change. "If that does not interest you particularly, then read this," we seem to hear continually. As the Science Service takes all science for its province, we have in

the books before us a variety in the contents which altogether forbids description. From about a hundred and forty articles which, with forty-four excellent illustrations, occupy some 350 pages of "Keeping up with Science," the titles of the first dozen are: Science and Pseudo-science, Chemical Messengers, The Smell of the Hive, How Baby Plants know the Way Up, Man sees 6,000,000,000,000,000,000 Miles, Making a Camera see Farther, The Warmth of a Snow Blanket, How Arrow-heads Are Made, The Hammering of Storms, Friendly Germs, Memory Knots, Champion Flyers.

The reviewer would like to say at once that he thinks Dr. Slosson is exhibited by these books as a man of very remarkable gifts, and that he has set in action a plan of popularising science which is of the highest interest and deserving of our closest attention.

In attempting to give some account of this plan, perhaps the first thing to be said is that Dr. Slosson appears in the guise of a modern journalist. One feels, from the title of the themes, from their composition, from their form, that the writer must surely have served a long apprenticeship in the art of savouring and serving news for the multitude. In saying so much we may seem to be paying a very dubious compliment, but there is surely something good to be done with the peculiar power which the best journalists acquire of putting what they have to tell in arresting form. The journalistic guise of Dr. Slosson will, however, be quickly penetrated by men of science, and as they read they will see the real scientific prophet that it masks. They will find under the surface of his light-hearted exposition and accompanying his quips and cranks, the evidence of a very serious purpose and a deep-laid scheme of worthy propaganda and genuine enlightenment. British readers will, of course, have to remember that what is written is for the American public. It would not quite do for us as it stands, but it nevertheless suggests the type of treatment that could be used for British readers.

The chief interest is in surveying the choice of themes, in seeing what sort of points Dr. Slosson attempts to make, and in observing the selection of facts, the fragments of philosophy, the intellectual stimuli that are used in achieving his purpose.

It seems to the reviewer to be extraordinarily well done, and that Dr. Slosson and his Science Service are greatly to be congratulated on their achievement. They have taken journalistic ground, and if it is said —and no doubt it will be said—that they deal slenderly with the science they implant thereon, it cannot be regarded as less than a triumph that they are rescuing journalistic science from the hands which habitually made of it nothing but a useless travesty. They are giving some true indication at least of the extent to which science interpenetrates the whole of our modern civilised life, and of the influence which it must inevitably have upon the greatest issues of human existence.

In one of the chats on science there are given some statistics which give a measure of the success attained. It appears that among the articles on biological science appearing during a month in fourteen prominent papers from as many different cities from Boston to Los Angeles, only a fifth of one per cent. of the matter was deemed fictitious by authorities from Teachers' College, Columbia. These same authorities declared, indeed, that—"Newspapers appear to be more up-to-date in things biological than are college and high school texts in the subject"; and in conclusion they turn tables on the teachers by advising them to make use of newspaper articles in class-room instruction in order to show that biology "is meaningful to the student." The success of Science Service in the United States, from the point of view of science as well as that of the public, makes us hope that an institution of a similar kind may be established in Great Britain. Whatever funds were provided to place such an organisation upon a sound footing would be returned many times in the form of increased attention to scientific study and support for scientific research.

A Great Physician.

The Life of Sir William Osler By Harvey Cushing. Vol. 1. Pp. xv + 685 + 20 plates. Vol. 2. Pp. xii + 728 + 21 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 37*s.* 6*d.* net.

THE awaited Life of Sir William Osler is before us. His subject "A Physician of Two Continents," the author has appropriately devoted the first volume to the Canadian and United States periods, while the second volume deals with the Oxford period. But to readers in the new world as well as the old, both volumes will appeal for the sake of Osler's great and lovable personality.

Dr. Harvey Cushing, who handles pen and scalpel with equal skill, has made Osler live again for us in these pages. He has mainly effected this by a similar method to that pursued by Lockhart in writing the Life of Scott. So far as is possible, extracts from Sir William's letters and the writings of his contemporaries are introduced to bring back the events of past days; the art of the biographer is declared in the way in which these documents fall naturally into the course of the main narrative. This indeed, as is stated in

a short foreword, has been Dr. Cushing's object, and he has not wished, for the present at all events, to appraise Osler's professional accomplishments. Most readers after perusing the book will agree that such comments would be superfluous.

William Osler was born on July 12, 1849, at Bond Head, in Upper Canada. He came of Cornish stock through both parents. His father was a clergyman, the Rev. Featherstone Lake Osler, who settled as a missionary in Canada in 1837 with his wife, Ellen Pickton, who died a centenarian. William, named after William of Orange, was the youngest son in a family of nine, nearly all of whom became distinguished in the affairs of their native country. At first destined for the church, the influence of two of his teachers, Johnson and Bovell, one a priest and school-master, first a theologian, secondly a naturalist, the other, a physician but at heart a priest, undoubtedly directed the young student's attention to medicine through the portal of natural science. Osler's studies of the Diatomaceæ and fresh-water Polyzoa led him on to Entozoa and eventually to work on blood-films in London and Montreal; to note malarial parasites at Philadelphia and the amœbæ of dysentery at Baltimore. He took his medical degree at McGill University in 1872, and then passed two years of study abroad in the course of which he worked at physiology and pathology under Burdon Sanderson, to whose future chair at Oxford in the fulness of time he was to succeed

In the 'seventies, medicine was being again revolutionised; to every port of knowledge came argosies rich in the new learning. Giants indeed were in those days; Darwin had written "The Origin of Species"; Huxley and Burdon Sanderson were making physiology a science, Pasteur was founding bacteriology, and Lister was re-making surgery; Ferrier was discovering cerebral localisation; Paget was wedding pathology to surgery; Virchow was teaching pathology in Berlin; and Villemin's researches had paved the way for Koch's impending discovery of the tubercle bacillus. Into the harvest of science came the young Canadian doctor, a worker as well as a gleaner. He returned to Montreal in 1874 as lecturer in the new subjects of physiology and pathology at his *alma mater*.

Ten years of scientific work followed, chiefly in pure pathology, but towards the end of the Canadian period, Osler had found his life-work. In 1884 he accepted the post of professor of clinical medicine in the University of Pennsylvania, and five years later was called to Baltimore as professor of medicine in the newly established Johns Hopkins Medical School. Dr. Cushing tells in detail the story of Osler's achievements here. He built up a wonderful Medical School; he was made a fellow of the Royal Society; he wrote a text-book, successive editions of which have been in the hands of medical students and medical practitioners throughout the world; he made it possible for the American students to study medicine in the wards by the bedside; he gained international reputation as a physician, a teacher, and a writer. At fifty-six years of age his cup overflowed with wisdom; yet fortune had more gifts in store for him, and the land of his ancestry claimed him as her own.

After refusing many calls to other positions, in 1904* he accepted the Regius professorship of medicine at Oxford. It is a chair in which one may grow old gracefully; the duties attached to the post are not onerous, and ample leisure might have been afforded for Osler's enjoyment of his library and literary pursuits.

Sir William (he received a baronetcy in 1911) was not a man to rest on his laurels. Within a short space of time his personality was felt in the ancient University, where he was soon known to the medical undergraduate as the most human of professors. He taught clinical medicine at the Radcliffe Infirmary; he proved himself a classic and a philosopher at the high tables of colleges, he and Lady Osler in their unbounded hospitality made Oxford the Mecca of every doctor and student and knit up a thousand close ties between England and America. His influence went far beyond Oxford in constant demands for lectures, addresses, committees, and consultations; he spent himself freely for the advancement of learning and the good of mankind. The aim of Osler's life is written in the preface to his text-book: "To feel that I may have been helpful in promoting sound knowledge is my greatest satisfaction." Needless to add, this feeling was amply justified. The War came and clouded his last days with irreparable sorrow, but to the end in 1919 he was the captain of his soul.

It has been stated that Osler made few contributions to science, and that his chief claim to fame rests on his unquestioned abilities as a teacher and exponent of clinical medicine There is scant justice in this view, supported, though it may be, by Osler's modest estimation of his own work. As has been mentioned, his bent for scientific research was shown in youth when, in his paper on the Diatomaceæ, he enumerated 110 species in 31 genera collected by himself. When only twenty-four years of age, he made the fundamental investigation of blood platelets and was the first to describe these bodies in the circulating blood. In 1877 he described a form of broncho-pneumonia in dogs, due to a previously unknown parasitic nematode to which Cobbold has given the name of *Filaria Osleri*. There is little doubt that, had he continued his studies in pure pathology, he would have taken high place

both as an investigator and teacher. In many respects he was more prescient than some of his contemporaries, for he early apprehended the importance of the new pathology and made it the basis of scientific medicine. This practice is so generally accepted to-day that we are apt to forget it is in large part due to Osler; through his work and teaching the modern presentation of medicine, based on known causes with signs and symptoms explained or verified in the *post-mortem* room and in the laboratory, has emerged.

Although a sedulous compiler of the work of others, in medicine itself Osler made numerous original observations In 1902, he described the condition of cyanosis with polycythæmia, known as Vaquez-Osler disease, and an hereditary malady characterised by multiple telangiectases associated with hæmorrhages may rightly also be styled Osler's disease. His Goulstonian lectures on malignant endocarditis, his lectures on the cerebral palsies of children, and his Lumleian lectures on angina pectoris, were based on a wealth of clinical experience and information. In addition to the work published under his own name, many important discoveries in various branches of medicine put forth by his colleagues and pupils can be ascribed to what Clifford Allbutt termed Osler's wonderful power, only possessed by a few great teachers, of "inseminating other minds"

As Dr. Cushing writes: "There were indeed many Oslers: the physician, the professor, the scholar, the author, the bibliophile, the historian, the philanthropist, the friend and companion for young or old." In literature and philosophy, his learning was profound, and his presidential address to the Classical Association at Oxford in 1919 on "The Old Humanities and the New Science" impressed his audience with his width of outlook, his easy mastery of great tracts of literature, and his all-embracing humanity in the widest sense of the term. Those who knew and loved Osler—and few men have been more personally beloved throughout the world—will feel grateful to Dr. Cushing for dwelling on the intimate aspect of Sir William's character, for revealing through his own words his infinite capacity for friendship and his unselfish aid to every one who came to him in doubt or difficulty. "He talked with crowds and kept his virtue, or walked with kings—nor lost the common touch."

Such is the story told by Dr. Cushing; the theme is noble, the book is worthy of its subject; there is little to criticise; we could have spared a page treating of the Royal College of Physicians from a mistaken point of view, and the addition of a complete list of Osler's published writings would have been desirable; but the matter is all pure gold and the book should rank as one of the classical biographies. A. S. M.

Our Bookshelf.

Trees and How they Grow. By G. Clarke Nuttall. New edition. Pp. xi+184+70 plates. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1923.) 7*s*. 6*d*. net.

MR. NUTTALL'S work is a chatty book about the botany, history, and literature of our common trees. The biological details are fairly accurate, attention being paid to the pollination of the flower, the distribution of the seed, and the growth of the seedling. Errors, however, are not infrequent in the other part of the text, mainly due to previous writers, from whom the author has compiled. The remarkable hazel tree, 60 feet high, at Syon House, Brentford, is not the common species (as stated on p. 5, an error due to Tollemache in 1901); but is *Corylus Colurna*, the Turkish hazel, a large forest tree of S.E. Europe and Asia Minor There are actually three magnificent Turkish hazels at Syon, ranging in height from 68 to 87 feet

The derivations of tree names in this book are mostly of the kind known as folk-etymology, and perpetuate time-honoured errors. The statement (p. 60) that the Lombardy poplar is a native of the Himalayas is without foundation, there being no doubt that it originated, as its name indicates, in the plain of the River Po. The statement (p. 16) that the word elm is a derivative of the Latin *ulmus* is incorrect, and certainly lends no support to the tradition that the common elm was introduced into Britain by the Romans. The wych elm is so called on account of its pendulous branches (A.S. *wice*, bending), and the etymology given on p. 16 is impossible. The derivation (p. 24) of the Latin *taxus*, yew, from the Greek τόξον, a bow, rests on a guess of Pliny and is not supported by any evidence. Absurd derivations of the Latin *alnus*, alder (p 47), and *carpinus*, hornbeam (p. 53), are put forward. Acorn means the fruit of the open country (A.S. *æcern*), and has no connexion (as stated on p. 104) with the A.S. *ac*, oak—the present spelling "acorn" being a good example of the influence of folk-etymology on the form of words. The word holly (p. 133) is not derived from the Norse, and has no connexion with the word *holy*. The A.S. name of the tree is *holen* or *holegn*, cognate with the Irish *cuileann* and the Welsh *celyn*. This name is as old as the A.S. *mapel* (*Acer campestre*), which is said (p. 141) to be an old British name, "handed down to us from days long before Anglo-Saxons were thought of; and it is the only plant whose name has come down from those days." This is a fairy tale without any foundation. The lime tree owes its name to a corruption of the A.S. *lind*, which survives in the adjective linden; and the explanation offered by Mr. Nuttall is baseless.

The book may be serviceable in Nature study classes, as it is cheap, readable, and provided with useful illustrations.

The Borders and Beyond: Arctic, Cheviot, Tropic. By Abel Chapman. Pp. xxi+489+35 plates. (London and Edinburgh: Gurney and Jackson, 1924.) 25*s*. net.

THIS book is a fine record of personal observation of wild life at home and abroad, and sets forth the opinions arrived at by the author as the result of many years

of practical experience of his subjects. He opens by discussing many points of interest in the life of the red grouse and other game birds. Faced with such questions as "Do grouse drink?" Mr. Chapman does not need to weigh the pros and cons or to meet opposing arguments: he simply knows, and has known from boyhood, that grouse do drink, and he can tell us how, and when, and where, with a wealth of circumstantial detail. Not least interesting are the chapters on what Mr. Chapman calls the "globe spanners," those species of waders, particularly, which breed only on the Arctic tundras but migrate so far as South Africa, Patagonia, Tasmania, and New Zealand. He knows some of them in their northern homes and on their migrations in Spain and in Africa, but especially he knows them on passage on the Northumbrian coast. Various aspects of wild-fowling are also dealt with, and it is only a wild-fowler who readily becomes familiar with such birds as the brent goose. Further chapters are devoted to "salmonology," and finally the author sums up his far from complimentary views about modern zoology and bird protection laws respectively.

Mr. Chapman has the defects of his qualities. He is too much out of sympathy with those who follow different lines of study, and he often fails to recognise the limitations of his own method. Thus, he seems to claim questions of evolutionary relationships for the peculiar province of the field observer, attaching more importance to the evidence of habits than to the less plastic features of fundamental structure. Again, it is untrue that the curlew is described by British ornithologists simply as a resident species (although, as the author gracefully puts it, "the precise verbiage may vary"); and the text-books may be pardoned for not following the author's example in dogmatically defining the winter-range of British native birds. The experiment with bats which the author ascribes to Thomson was merely quoted by him.

The numerous illustrations are just what one would wish for in such a work, namely, field sketches from the author's own pencil: these are reinforced by some excellent coloured plates by Mr. W. H. Riddell.

Tabellen zur Röntgenspektralanalyse. Von Paul Günther. Pp. iv+61. (Berlin: Julius Springer, 1924.) 4·80 gold marks.

X-RAY spectroscopy has already invaded the domain of chemical analysis and is no doubt destined to play an ever-increasing part in this field. It is to meet such a situation that Dr. Günther has compiled this handy volume of tables. He has departed from the conventional method of classifying the lines under elements and has tabulated them in order of increasing wave-length. Such an arrangement, while suited for the special purpose for which the tables are intended, may not be very popular among physicists, who will probably prefer the more usual method; their needs have, however, already been catered for in various publications. In addition to the wave-lengths and their identification, this table gives, for the more important lines, the reflecting angles for the crystals commonly used with the spectrometer. The actual values given are largely based on the measurements of Siegbahn and his school, but in the *K* series of the elements of higher atomic weight it is surprising to find that the wave-lengths given are not those of the latest and most accurate determinations, and differ in some cases considerably from those given by Siegbahn and de Broglie. This divergence appears to be confined to this set of lines. With this exception, the table has been very carefully constructed and is very complete. In addition, Dr. Günther gives in the introduction a brief description of the characteristics of X-ray spectra, and concludes with a series of tables on absorption coefficients, critical exciting voltages, and the like. In following the example of Siegbahn and including these tables, the author has materially increased the value of the book. The printing and general arrangement are excellent, and the volume should prove a useful reference book to all engaged in X-ray spectroscopy.

Biologie der Tiere Deutschlands. Herausgegeben von Prof. Dr. Paul Schulze. Lieferung 6, Teil 4: *Turbellaria*; von Erich Reisinger. Pp. 4 64. 1*s.* 3*d.* Lieferung 7, Teil 42: *Hymenoptera* .; von H. Bischoff. Teil 49: *Amphibia*; von A. Remane. Pp. 42.64+49.34. 1*s.* 10*d.* Lieferung 8, Teil 42: *Hymenoptera II.*; von H. Bischoff. Pp. 42. 65-156. 1*s.* 10*d.* Lieferung 9, Teil 34: *Ephemeroptera*; von Georg Ulmer. Teil 50: *Reptilia*; von A. Remane. Pp. 34. 40+50. 29. 1*s.* 8*d.* Lieferung 10, Teil 32: *Plecoptera*; von Ed Schoenemund. Teil 40: *Coleoptera I.*; von H. v. Lengerken. Pp. 32. 34+40. 36. 1*s.* 10*d.* (Berlin: Gebruder Borntraeger, 1923–1924)

WE welcome a further instalment of the parts of this extremely useful work on the natural history of the animals comprising the fauna of Germany. About one-third of the whole has now been issued, and as publication is apparently being pushed forward rapidly, the completion of the work may be looked for at a not too distant date The parts under notice follow closely the lines laid down by previous parts, and the high level of excellence of the earlier series is well maintained. It is perhaps invidious to select any part for special mention, but the section dealing with the Hymenoptera seems to us to be a remarkably concise account of the biology of this large and varied group of insects. A work on similar lines dealing with the British fauna is urgently needed

Handbuch der Balneologie, medizinischen Klimatologie und Balneographie. Herausgegeben im Auftrage der Zentralstelle für Balneologie von Prof. Dr. Dietrich und Prof. Dr. Kaminer. Band 4. Pp. xii+379. (Leipzig: Georg Thieme, 1924.) 3·80 dollars.

THIS treatise on balneology, etc., to be completed in five volumes, deals with the subject very completely. The volume under review includes the technique of hydrotherapy, sea-water baths, radio-active waters and hydro-electro-therapy, sunlight therapy and diets, and the therapeutic action of climate—low and high altitudes, desert air, and ocean travel.

The section on sunlight therapy, by Dr. Bernhard of St. Moritz, is of considerable interest, and the illustrations showing the condition before and after treatment of patients suffering from tuberculous sinuses, wounds, and the like are a striking testimony to the value of this form of treatment.

The various sections, which are all written by specialists, give the latest available information on the subjects with which they deal.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Effect of the Earth's Rotation on the Velocity of Light.

IN the *Philosophical Magazine* (6), 8, 716, 1904, an experiment was described, designed to test the effect of the earth's rotation on the velocity of light In consequence of atmospheric disturbances, it was quite impossible to measure the interference fringes in the open air. Accordingly a twelve-inch water-pipe was laid on the surface of the ground in the form of a rectangle, 2010 ft by 1113 ft The residual pressure was reduced to about one-half an inch by means of a fifty horse-power pump One of the ends was double, as shown in Fig 1 At *A*, light from a carbon arc

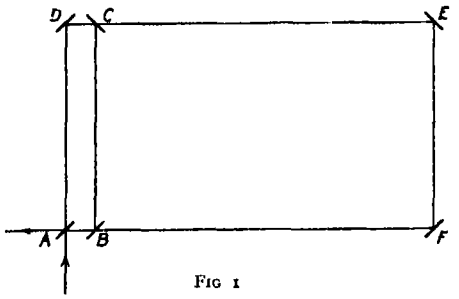


FIG 1

was divided by a plane parallel plate, thinly covered with gold, into two beams, one traversing the circuit in a clockwise, the other in a counter-clockwise direction

Observations showed that the beam going in the counter-clockwise direction was retarded with respect to the other by 0 230 of a fringe

TABLE I

	Displacement in Fringes	Number of Observations	Deviation from Mean
1	0 252	20	0 022
2	255	20	·025
3	·193	20	·037
4	·246	20	016
5	235	20	·005
6	·207	26	·023
7	·232	20	·002
8	·230	20	·000
9	·217	20	·013
10	·198	20	032
11	·252	20	·022
12	·237	20	·007
13	0 230	23	0·000
	Mean 0·230	Total 269	Av dev from mean 0 016

Observations 1-6 inclusive, without collimator; 7-13 inclusive, with collimator.

	Obs.	Calc.
Displacement . .	0·230 ± 0·005	0·236 ± 0·002

The theoretical value,[1] on the assumption of a stagnant ether, is given by the formula $\Delta = \frac{4A\omega \sin\theta}{\lambda c}$.

[1] This is twice the value given in the original article Attention was directed to this correction by L Silberstein in the Journal of the Optical Society of America, 5, 291, 1921.

With the actual dimensions of the apparatus, the calculated displacement is 0·236 of a fringe. In this formula the latitude, θ, is 41° 46′, and the wave-length, ω, as measured by comparison with sodium light, is 5700 Å U.; ω is the angular velocity of the earth's rotation, and c the velocity of light.

Two hundred and sixty-nine observations were made, and averaged, usually in groups of twenty, in the order taken Thirteen such means are given in Table I

The results are interpreted to mean that the calculated and observed displacements agree to within the limits of observational error.

A A MICHELSON
HENRY G GALE

University of Chicago,
March 21.

Atmospheric Electric Transmission.

IT appears to be of interest and value, in relation to current investigations on the circumstances of wireless transmission at short ranges, to note the intensity of reflection of electric waves that might be expected at the sharp boundary of an ionised layer, high in the atmosphere The term sharp here implies practically that the transition is completed in, say, not less than one-tenth or, for nearly direct incidence, one-fifth of a wave-length The relative amplitudes in the reflected waves are then, for the two polarised components, given sufficiently by the Fresnel expressions

$$-\frac{\sin(i-r)}{\sin(i+r)} \text{ and } \frac{\tan(i-r)}{\tan(i+r)}.$$

When the index of refraction μ is $1-\nu$ where ν is small, they become

$$-\frac{\nu}{2\cos^2 i} \text{ and } \frac{\nu\cos 2i}{2\cos^2 i},$$

e g for rays inclined at 30° to the horizontal they are -2ν and $-\nu$

For the most favourable case (NATURE, November 1, 1924, p. 650,[1] or *Phil Mag*, December, p. 1031), that of free ions, N per cubic cm, unhampered by collisions, therefore high up, the value of ν is

$$\tfrac{1}{2}N\lambda^2\frac{e^2}{\pi m},$$

which is $\frac{1}{2}\times 10^{-8}N$ for free electrons and for wave-length of one kilometre To ensure a reflection of 10 per cent. in amplitude (or 1 per cent in energy) of rays inclined at 30° as above, N would have to be about 300 electrons or else 5×10^5 hydrogen ions per cubic cm. If the wave-length is 10 times smaller, namely, 100 metres, these numbers have to be multiplied by 10^2

At the other extreme, if a gradual transition is to bend round the complete ray through the same angle of 60° in traversing a curve of whatever length, the difference of the values of N at the top and bottom of this curved path figures out (*cf loc. cit.*) of the order of 300 electrons per cubic cm when λ is one kilometre, much the same density of ions being thus necessary in the two cases.

For the first case, however, that of transition practically sharp, a layer a few wave-lengths in thickness would play the part of Newton's thin plate in optics, by reflecting from both its faces: thus as the wave-length is gradually changed, there would be regular fluctuations at the receiver. Ionic clouds drifting across the sky might cause irregularity of

[1] At top of column 2 read $\frac{1}{2}\times 10^{-2}$ watts per square cm.

communication in this way. In the other case, two regions, each with N increasing upwards, would be required for such interference.

According to observations recently reported, wave-fronts guided along the ground are inclined to the vertical at an angle α of the order of a degree at most; as the fronts travel with their proper velocity c', appropriate to air, their trace travels along the ground with velocity $c'/\cos\alpha$ this does not differ enough from c' to show interference at the receiver between ground waves and free air waves.

JOSEPH LARMOR.

St. John's College, Cambridge,
April 5

Diffusion of Momentum by Air Currents.

THERE is a wide difference between the actual rate at which contiguous streams intermix and that indicated by the ordinary theory of stream-lines supplemented by corrections for the effect of viscosity In this theory, for non-viscous fluids, the total energy of every element is identical and constant, and the boundary conditions and those of continuity must be satisfied With the assumption that the motion is stable, these suppositions lead to the following conclusions The flow is irrotational A solid of any shape whatever would experience no resistance, but when once started would continue to move with a constant velocity There is a variation of pressure over the leading surface which is exactly balanced by corresponding variations at the rear end

It is only in exceptional cases, and where fish-shaped forms are concerned, that any approach to the realisation of this kind of flow occurs in Nature, but in such forms where the cross-section area of the solid changes very gradually, there is a considerable replacement at the stern of the excess of pressure on the head Any abrupt change of section causes the stream-lines to leave the surface of the solid

Another solution of the stream-line problem leads to results which have more resemblance to reality In this the fluid is divided into two regions by a bounding surface of which that of the solid forms a part. In both regions the pressures at a distance are the same but the velocities are different Any portion of the fluid wholly within either region is without molecular rotation. Rotation, however, will exist if the part chosen includes any part of the boundary. The form of the boundary (when the solid is a plate moving in the direction of its normal) is sketched in Fig. 1.

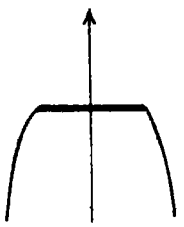


FIG. 1.—Form of the discontinuous stream-lines of a flat plate moving in the direction of the normal.

The solid experiences resistance and therefore continuously generates momentum in the fluid. The boundary of the two regions where the velocity changes discontinuously extends to infinity in the down-stream direction, and hence this class of stream-line cannot be initiated by any practicable method

Lord Kelvin pointed out that though this solution did not properly apply to a solid immersed in a fluid, the calculated shape of the boundary does accurately represent the shape of the vacuous cavity which would be formed on the down-stream side of the solid were no such force as gravity in action.

The striking difference between the real and calculated motions of fluids depends primarily on the instability of the latter. If in any group of stream-lines the flow at some point in one tube is artificially retarded for a moment, expansion occurs in that tube and the pressure increases. At the same time, the conditions of continuity cause a constriction in the neighbouring tubes with a corresponding decrease of pressure. Hence such a disturbance, once started, has no tendency to die out, and the "aneurism" in the retarded stream will continue to grow.

Suppose that in a large body of fluid a small spherical portion were set in motion by an impulse. At the first instant the pressures would be arranged as shown in Fig 2, *a*, and if flow of the "electric" type continued, the momentum would be confined to the sphere, which, however, would alter its shape under the action of the surface forces, gradually spreading into a thin circular sheet, the velocity of the centre of mass remaining constant. But although at the start the electric type of motion must prevail, it will last only for a moment, and before any appreciable distance has been travelled, the stream will have left the spherical boundary and taken the form shown in Fig 2, *b*

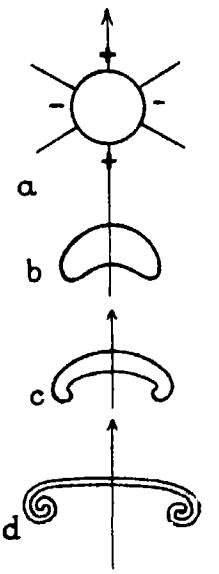


FIG 2.—*a*, distribution of pressure round a sphere, when the flow is of the "electric" type The signs + and − signify that the pressure is greater or less than that of the fluid at a distance *b*, *c*, and *d* indicate the successive forms taken by the sphere in real fluids, leading in the end to the formation of a ring

The mass originally set in motion still tends to spread into a sheet, but this will no longer remain flat, and in the course of time its edges turn backwards and inwards, eventually forming a kind of annular eddy half made up of fluid from the sheet and half from the fluid behind it (see Fig 2, *c* and *d*) The rings produced by puffs of air issuing from a symmetrical orifice (and often wrongly called "vortex" rings) are formed in this way

If, instead of single puffs, a continuous stream of air is expelled, the effects of instability may take different forms When the velocity of issue is small, and the surrounding air perfectly still, the stream may remain straight and unbroken for many times its own diameter, but sooner or later it begins to wander like a river in an alluvial plain, and wherever these bends occur, the stream section changes to a ribbon-like form with a roll at each edge As soon as the river-bends make acute angles with one another the stream spreads into broad sheets which soon become inextricably mixed, the whole having a strong resemblance to cumulus clouds

If the air into which the stream issues has the smallest velocity across the orifice, the change to ribbon form starts at once, and in favourable conditions (that is, where the velocities are small and regular) the column expands fan-wise with proportionately growing rolls at each edge. This may often be seen when a cigarette end is smouldering in nearly still air, and I have once or twice seen the same phenomenon over a factory chimney, the width of the upper part of the fan certainly exceeding two hundred feet. Out-of-door weather conditions, however, make such perfect examples very rare.

The terminal condition of all mixed currents is what I have referred to as the "cumulus" state, and in appearance it may vary from well-separated sheets with rolled edges to densely packed and voluminous

clouds, according to the relative velocities of the parts. It can be recognised on various scales ranging from a puff of tobacco smoke to the motions in solar prominences.

The tendency of streams to spread into sheets under the influence of instability is quite general, and appears to be the chief agent in the diffusion of momentum.

Smoke forms a convenient means of making these motions visible to the eye, and the accompanying reproductions of photographs (Fig 3) illustrate the smoke columns formed above a lamp fed with xylol. The latter yields a dense smoke, and the photographs, besides showing the various phases of instability, indicate also the manner in which "blacks" are formed The carbon deposited in combustion is



FIG. 3. Instantaneous photographs of smoke columns. The smoke was produced by the combustion of xylol.

swept into the rolls bordering the spreading sheets.[1] These rolls become broken up in the "cumulus" stage, and here the blacks are seen in all positions

A large number of photographs has been taken (using a spark from a Leyden jar as the illuminant), but those reproduced are fairly characteristic.

There is a curious quasi-periodic arrangement in the "blacks" where the smoke column is unbroken, the time interval being of the order of 1/150 to 1/200 second It appears in all the photographs, though not clear in the small scale reproductions, but what the origin of the period may be I do not know

A MALLOCK.

9 Baring Crescent, Exeter,
February 12.

[1] When the "blacks" are caught in a suitable bedding material and sectioned, the volute structure can be recognised.

A Course of Faraday.

NATURE is no longer merely "a weekly journal of science" but now both looks after our literary p's and q's and often is full of humour This is right and proper. We have only to think what science would be, if, for example, we took seriously imperious dismissals of the ether, such as we are favoured with by a high official of the Royal Society The delightful way in which other guardians of cosmic theory agree to differ is worthy of the best traditions of the House of Commons, if not of the Geological Society in its most palmy disputatious days. We still need, however, to introduce some sense of the ridiculous into chemistry The reviewer ("Our Bookshelf," March 14) is hard on the author of "Practical Forestry," who, after asking, "Why is coal put between species of stone or rock?" replies, "Because the Almighty put it there, and no expert or scientist breathing will ever make the writer believe otherwise." "Scientific truth" is stranger than such fiction. Physical chemists, biologists too, speak in just the same way of the teutonic myths they administer to unquestioning would-be graduates in science. What, indeed, is the professor for but to profess? His not to reason why, his but to do or die, at the hands of the examiner.

My fancy has been specially tickled by the "Alice in Wonderland" title, in which my name appears, at the head of a letter on March 14: "Graphitic Conduction in Conjugated Chains of Carbon Atoms: a Contribution to Armstrong's Theory of Chemical Change." I could never have supposed that any "theory" I might propose would be hung in such "Conjugated Chains" The nearest thing to "Graphitic Conduction in Conjugated Chains" I can think of is the school lesson the Mock Turtle had in *Fainting in Coils*

What is all the fuss about? What is Graphitic Conduction? A chemical *Tar Baby*, perhaps? I wonder. Why this christening party over conduction at all? Surely the two recognised forms, metallic and electrolytic, meet our needs.

The writer of the letter has a most unconscionable and reprehensible habit of putting new labels upon over-labelled bottles. I suppose, a trick acquired by constant association with a society the great aim of which seems to be to propagate Christian names among chemists In the very first paragraph, he insults two dear old friends of mine, ethylic acetacetate and nitrocamphor, the latter one of my own failed-children, by calling them *prototropic* compounds—a first-aid or first-love sort, I can only imagine, from my knowledge of Greek He ought to have been in the Church—to satisfy his lust to proselytise and re-christen This is an unnecessary act of word-pornography, in my opinion Elsewhere, he has called water an *Ampholyte*. Poor molecule. If hydrolyte be something which can be cut by water, ampholyte must imply something that can be cut by two: we gain nothing from such vicarious, bemuddled super-naming It is more than a shock to me that one of my most distinguished pupils, whose laboratory work is of such exceptional merit, should develop so perverse a habit

While re-naming unnecessarily, he seems to have no clear conception of the meaning of the old words he uses and not much "feeling" for the process he is discussing To me, however, his letter is of extraordinary psychological interest. After many years wandering in a mythical wilderness of Arrhenic ions and mathematical jugglery, the writer seems at last to be "feeling a want" to return to a watered and more fertile region. The doctrine I vainly endeavoured to plant in his soul seems to have been in subconscious operation and is now coming to the surface: the son, I am inclined to believe from close observation in my own family, does tend, more and more, to resemble his parent as years go on. The explanation my old pupil advances of the isomeric change he discusses is in principle, though in a very stilted form, that current in our laboratory from the time that Mr. Briggs and I discovered that the change of acetylphenylchloramine into the isomeric chloranilines was due to a trace of chlorhydric acid.

NATURE is not the place to discuss so technical a problem further At the moment, what we most need in chemistry is to get down to fundamental facts, to consider what is known and to treat this in the simplest possible terms. I recommend a course of Faraday to this end. I have not the slightest desire to receive recognition of any views I may have put

forward—the time for that sort of thing is past. What I do desire to see, however, is an attempt by chemists to be logical and to follow the as yet dimly written canons of scientific method. There is little health in much of the present science, because there is no law in it. My pupil's attempt to clear his mind, by discussing a chemical problem with some regard to the process of change, is a great departure from the current practice. I am grateful to him for the advertisement he would give to my "dictum," as he calls it. Not my dictum—but Faraday's finding and assertion, dating as far back as 1833.

I would urge my good trumpeter to follow the example of Michael Pupin, the one time Serbian peasant boy, as set out in his charming autobiography, "From Immigrant to Inventor." Pupin tells how he came to Cambridge (England) and was coached by Dr. Routh but dared not enter as a student under J. J. Thomson, then recently appointed professor, only two years his senior—because he knew nothing of practical physics. So he bought there the three volumes of "Faraday's Collected Researches in Electricity," for three shillings, a wonderful proof of the esteem in which electricity was then held in Cambridge (England) but still about or above the value put upon the books by chemists to-day. He adjourned with these to Corrie in Arran, but for a time took instead to practising the Highland Reel, in Glen Sannox, under the engaging tuition of a Scotch lassie. Eventually, however, like Moses, he went up to the mount, to a crofter's hut, where he lived simply on oatmeal porridge and Faraday. So it came that his mind was filled with visions of electromagnetic theory, with the result that he is now a wealthy man, through the invention of the loading coil used in reinforcing telephone circuits.

I bought Faraday's three volumes in a job lot of books, in the early 'seventies, at Stevens' auction rooms, at a not much higher price than Pupin did. I was specially fascinated by the electrochemical researches and those on the catalytic action of platinum. I read these over and over again—eventually I became a public preacher of Faraday's doctrine of the unity of chemical and electrolytic change. I should add that, at an earlier period, I had learnt to have faith in oxygen, indeed, to reverence it among the elements—a faith the modern "chemist" lacks. He will not be a chemist until he recover it. I would advise my old pupil and all who desire to arrive at an understanding of chemical change to retire into the mountains with Faraday's volumes and Wiedemann's "Electricitat" and really study them—with or without the aid of Highland lassies but taking into account the wonderful work done by H. B. Dixon, H. B. Baker *and* Lowry on the conditions of chemical change. Dancing, of course, is in these days an act of Nature. Let them, however, learn to dance to the simple old melodies, not to the loose and illogical jazz which has so long hypnotised their minds.

One final sentence as to graphitic conduction. Surely there is no reason to believe that it is otherwise than electrolytic and due to an impurity—to intruded salts—like that of quartz. As to alternate single and double bonds in benzene, the conception probably exists only on paper. The facts all tend to show that the six atoms in a "chunk" of benzenoid carbon are equally related, hexagonally not trigonally. This is the idea underlying my *Centric Symbol*, which, I submit in all humility, is the nearest approach to a plane formula yet devised or likely to be. We shall not know benzene until we think of it corporeally—not as a few straight strokes with the pen.

HENRY E. ARMSTRONG

Some Notes on the Taungs Skull.

A FEW days ago I visited Johannesburg to have a look at the remarkable new skull discovered by Prof. Dart, and named by him *Australopithecus africanus*. Prof. Dart not only allowed me every facility for examining the skull, but also gave me with almost unexampled generosity full permission to publish any observations I made on it, and suggested further that I might send to NATURE any notes that might amplify the account he had already given. As the skull is one of extreme importance, a full account with measurements and very detailed figures will in due course be published by Prof. Dart, but the world already realises the unique character of the discovery and is anxious for more immediate information.

From the cablegrams received in South Africa, it is manifest that the first demand is for further light on the geological age of the being, and unfortunately complete information on this point cannot now be given, and will possibly never be available. Though I have not myself visited the Taungs locality, I am fairly familiar with many similar deposits farther south along the Kaap escarpment. This escarpment runs for more than 150 miles along the west side of the Harts River and lower Vaal River valleys from a little south of Vryburg to 20 miles south of Douglas. The escarpment is formed for the most part of huge cliffs of dolomitic limestone of the Campbell Rand series, in most places some hundreds of feet thick. The wide valley has an interesting geological history. Originally it was carved out in Upper Carboniferous or Lower Permian times by the Dwyka glaciers. For millions of years it was steadily refilled by Dwyka, Ecca, and Beaufort beds until the whole valley was perhaps buried by more than 2000 feet of Permian and Triassic shales. Then conditions changed and the valley was re-excavated, by denudation, until to-day we find it not unlike what it must have been when originally carved out by the Dwyka glaciers.

The dolomite escarpment forms the most striking feature of the landscape in this part of the world. All along the west of the Harts-Vaal valley lies the high dead-level Kaap plateau, and when viewed from 20 miles away the escarpment looks like a high black wall bounding the lower plain of the valley. Every five or ten miles along the black wall are to be seen large light-coloured patches which on examination prove to be great masses of calc-sinter formed by calcareous springs. These, of course, must have been formed after the dolomite cliffs had been denuded of their covering Dwyka shales, and may in some cases be of considerable age—perhaps even dating from moderately early Tertiary times. Other masses of this secondary limestone may be of comparatively recent date. In places the great masses of calc-sinter have been excavated by underground water and moderately large caves are formed.

At Taungs the mass of secondary limestone is some hundreds of feet thick and about 70 feet high where it is being worked. Already 250 feet have been quarried away. On the face about 50 feet below the top of the mass, an old cave is cut across which is filled up with sand partly cemented together with lime, and it is in this old cave that the skull of Australopithecus has been found. The only other bones that I have seen or heard of are skulls and bones of a baboon, a jaw of a hyrax, and remains of a tortoise. I have not seen the hyrax jaw, so cannot say if it belongs to one of the living species. The baboon has been examined by Dr. Haughton, who regards it as an extinct species and has named it *Papio capensis*. I have seen a number of imperfect skulls of this baboon, and while they belong to a different species from the living local

Papio porcarius, the difference between them is not so very striking

I think it can be safely asserted that the Taungs skull is thus not likely to be geologically of great antiquity —probably not older than Pleistocene, and perhaps even as recent as the *Homo rhodesiensis* skull. When later or other associated mammalian bones are discovered, it may be possible to give the age with greater definiteness At present all we can say is that the skull is not likely to be older than what we regard as the human period But the age of the specimen in no way interferes with its being a true " missing link," and the most important hitherto discovered.

Prof. Dart in his photographs has given the general features of the skull and the brain, but there are a number of important characters in the skull and dentition to which I should like to direct attention

Though the parietals and occipital are almost completely lost from the brain cast, most of the sutures can be clearly made out, and are as I indicate in Fig 1 The sutures in the temporal region can

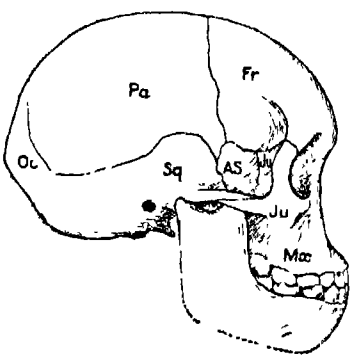


FIG. 1 —Side view of skull of *Australopithecus africanus*, Dart About ⅓ natural size.

also be clearly seen. The suture between the temporal bone and the parietal is fairly horizontal as in the anthropoid apes, but in the upward development of the squamous portion we have a character which is human and not met with in the gorilla, the chimpanzee, the orang, or the gibbon.

The arrangement of the sutures in the temporal region is also remarkably interesting. The upper part of the sphenoid articulates with both the parietal and the frontal In the gorilla and chimpanzee in all the drawings I can find the temporal bone meets the frontal and prevents the meeting of the sphenoid and the parietal In the orang the condition varies, and I have in my possession a skull which has on the right side a spheno-parietal suture and on the left a fronto-temporal In the baboon there is a large fronto-temporal suture, and in Cercopithecus a spheno-parietal suture In the gibbon there is also a spheno-parietal suture While the arrangement of the sutures in this region may not be of very great fundamental importance, it is interesting to note that Australopithecus agrees with man, the gibbon, and Cercopithecus, but differs from the gorilla, the chimpanzee, and the baboon

The jugal or malar arch is interesting in that there is a long articulation between the jugal and squamosal. In this Australopithecus agrees rather with the anthropoids than with man.

On the face there are one or two striking characters, and of these perhaps the most important is the fusion of the premaxilla with the maxilla. On the palate the suture between these bones is seen almost as in the human child, the suture running out about two-thirds of the way towards the diastema between the second incisor and the canine On the face there is no trace of any suture in the dental region, but on the left side of the nasal opening there is what is probably the upper part of the original premaxilla-maxillary suture. On the right side there is a faint indication of a suture just inside the nostril. In the chimpanzee the suture becomes obliterated in the dental region early, as apparently is the case in Australopithecus In the orang and gorilla the suture remains distinct until a much later stage. In man, as is well known, all trace of the suture is obliterated from the face long before birth.

Australopithecus agrees with man and the chimpanzee in having a single foramen for the superior maxillary nerve. In the orang, gibbon, and other apes there are usually two or more foramina. In the gorilla sometimes there is one foramen ; sometimes two.

In the shortness of the nasal bones and the high position of the nasal opening the Taungs skull agrees more with the chimpanzee than with the gorilla.

The dentition is beautifully preserved, and the teeth have been cleared of matrix by Prof. Dart with the greatest care Though, owing to the lower jaw being in position, a full view of the crowns of the teeth could only be obtained by detaching the lower jaw, a sufficiently satisfactory view can be obtained to give us practically all we require of the structure

The whole deciduous denture is present in practically perfect condition The incisors, which are small, have been much worn down by use, and most of the crowns of the median ones have been worn off Prof Dart has directed attention to the vertical position of the teeth, which is a human character and differs considerably from the conditions found in the chimpanzee and gorilla The small size of the incisors is also a human character

The relatively small size of the canine is a character in which Australopithecus agrees with both the chimpanzee and man, and lies practically between the two.

The deciduous molars agree more closely with those of man than with those of any of the apes.

The first permanent molars of both upper and lower jaws are perfectly preserved and singularly interesting.



FIG. 2 —First right upper molars : A, orang (after Röse) ; B, *Australopithecus africanus*, Dart, unworn ; C, Bushman child, unworn. All natural size

The first molar of the upper jaw (Fig 2) has four large cusps arranged as in man and the anthropoid apes.

The first lower molar (Fig. 3) has three well-developed sub-equal cusps on the outer side and two on the inner. Though in its great length and in the large development of the third outer cusp or hypoconulid the tooth differs considerably from the typical first



FIG 3 —First right lower molars A, old chimpanzee, worn (after Miller) ; B, *Australopithecus africanus*, Dart ; C, Bushman child. All natural size

The arrangement of the furrows on the crown of the molar of Australopithecus is almost exactly similar to that in both the orang and the Bushman. In the chimpanzee and gorilla, there is usually a well-marked ridge passing from the protocone to the metacone, of which there is an indication in the Bushman tooth.

lower molar of man, teeth of this pattern not infrequently occur in man. In general structure, however, the tooth more closely resembles that of the chimpanzee. It is interesting to compare this tooth with the corresponding tooth in Eoanthropus.

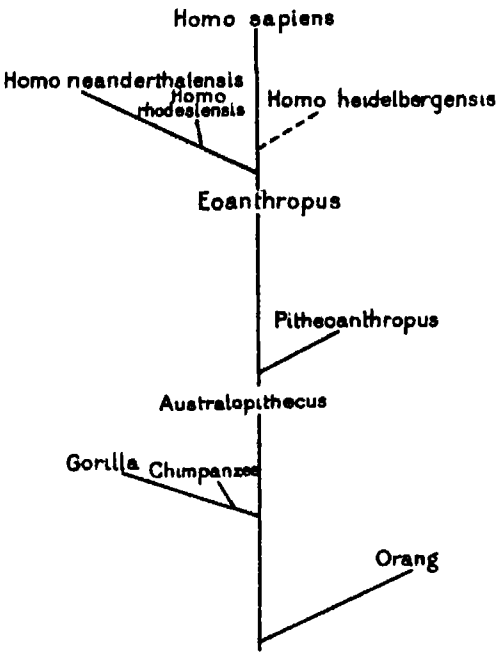


FIG. 4

It will be seen that in *Australopithecus africanus* we have a large anthropoid ape resembling the chimpanzee in many characters, but approaching man in others We can assert with considerable confidence that it could not have been a forest-living animal, and

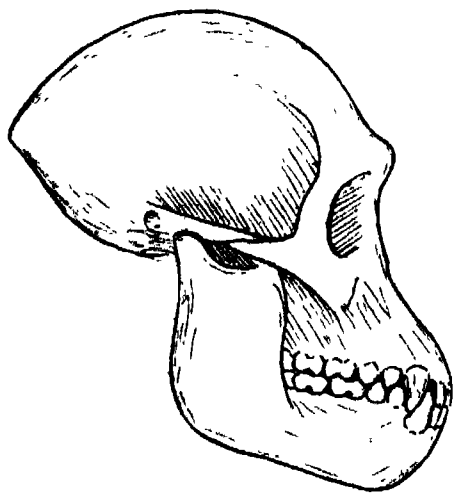


FIG. 5.—Attempted reconstruction of adult skull of *Australopithecus africanus*, Dart. About ½ natural size.

that almost certainly it lived among the rocks and on the plains, as does the baboon of to-day. Prof. Dart has shown that it must have walked more upright than the chimpanzee or gorilla, and it must thus have approached man more nearly than any other anthropoid hitherto discovered.

Eoanthropus has a human brain with still the chimpanzee jaw. In Australopithecus we have a being also with a chimpanzee-like jaw, but with a sub-human brain. We seem justified in concluding that in this new form discovered by Prof. Dart we have a connecting link between the higher apes and one of the lowest human types.

The accompanying table (Fig. 4) shows what I believe to be the relationships of Australopithecus. If an attempt be made to reconstruct the adult skull (Fig 5), it is surprising how near it appears to come to *Pithecanthropus erectus*—differing only in the somewhat smaller brain, and less erect attitude.

While nearer to the anthropoid apes than man, it seems to be the forerunner of such a type as Eoanthropus, which may be regarded as the earliest human variety, the other probably branching off in different directions.

There seems considerable probability that adult specimens will yet be secured, and if the skeleton as well as the skull is preserved, the light thrown on human evolution will be very great R BROOM

Douglas, South Africa.

The Skull of Robert the Bruce.

A LETTER to NATURE is perhaps not the suitable place to discuss the historical evidence for sporadic syphilis being well known in Europe from at least the ninth century, nor do I intend at present to controvert Sir Arthur Keith on several other points in which he disagrees with me in his recent friendly review of my "Bruce" (NATURE, February 28, p 303). But there is one point at which Sir Arthur seems to me to show less than his usual acumen He concludes his article with the words: "The writer [Sir Arthur] has searched the pre-medieval graves of England and Scotland for traces of syphilis and found none, and those who know our medical records believe that Robert Bruce had been asleep in Dunfermline Abbey for two centuries before this fell disease appeared in Britain"

Now I strongly suspect that Sir Arthur Keith has overlooked two important considerations. (1) that he has been thinking largely of skeletons dug up from abbeys, and (2) that he has disregarded the fact that the nature of a disease changes with the centuries. Now abbeys in the tenth to the thirteenth centuries were not those seats of vice that a good compatriot of George Buchanan naturally assumes them to have been Further, the sporadic cases of the disease were undoubtedly confused with leprosy, and it is not in the abbey graveyards, or in the churchyards of the tenth to the fourteenth centuries that I should expect to find evidence of these sporadic cases of syphilis Sir Arthur should search in the burial-places attached to leper-houses, and even then he must not expect of a certainty to find the osteological appearances identical with those of the post-pandemic times

St Hildegard in her "Causae et Curae" of the twelfth century describes under leprosy cases which are certainly not leprosy, but as certainly syphilis. She was quite familiar, as Hildebrand has lately demonstrated, with the general paralysis of the insane. The same writer has also recently proved beyond a doubt that St. Odo of Cluny (*circa* 930) was acquainted with the disease as a result of sexual licence:

Irrepsit vitium—nec jam est simplex neque solum.
Ulcus enim vultum foedans facit esse probrosum,
Et vitium attaminat membrum, cui forsan adheret
At si vulnus abit, de more glabella nitescit,
Membra decore suo remitent vitioque revulso
Post lapsum sensus terebrat quasi rima libido;
Illicit, illecebrat, tabo crapulosa saginat.

How shall a man in such state appear on the Day of Resurrection? the worthy Abbot demands. Even the "saddle nose" so characteristic of the tertiary stages of the disease was recognised in association with sexual licence in the eleventh century. The recent studies of Karl Sudhoff and Philipp Hildebrand seem to me to demonstrate that syphilis existed in Europe, if not in the pandemic form of the fifteenth century, still in not very infrequent cases from the early Middle Ages onwards.

Sir Arthur writes that the "very able medical men who examined the king's skull and bones" had no suspicion in their minds of syphilis. Possibly not, their report is very inadequate, and they held probably the orthodox view, like Sir Arthur, that syphilis was unknown in Europe before the time of Columbus. But these same medical men did direct attention to the condition of the upper jaw, and to the exfoliated wound on the right side of the sagittal suture, and endeavoured to give explanations of them. These explanations may be correct, but there is the awkward fact that Bruce is said to have died of "leprosy" still unaccounted for.

KARL PEARSON.

Eugenics Laboratory,
University of London.

In his interesting letter Prof. Pearson discusses two questions: (1) Did Europeans suffer from syphilis before the return of Columbus from America? (2) Does the skull cast of Robert Bruce give any indication that the king suffered from syphilis? I can see nothing in the skull cast symptomatic of this disease, the points mentioned by Prof. Pearson are not in my opinion indicative of syphilis.

If syphilis had existed among the Romano-Britons or Saxons, I should have met traces of it by now. There was no syphilis in ancient Egypt, of the many thousands of skulls and bones which have been examined, not one showed the unmistakable lesions of syphilis. I confess that the rise and spread of syphilis in Europe during the sixteenth century is an enigma. It can scarcely have come from America, for syphilis has not been seen in graves of a pre-Columbian date. Lately it has been announced that the lama of South America has been found to be highly susceptible to syphilis. Is it possible that syphilis was not evolved as a disease of the human body?

A. KEITH.

A Peculiarity of some Red Neon Lines.

THE neon discharge lamps recently introduced by Messrs. Adam Hilger for spectroscopic purposes are so convenient that they are likely to be widely used. It may, therefore, be worth while to direct attention to a peculiarity of some lines of their spectrum. In the course of work with a Fabry-Perot etalon, two of the lines appeared to be doublets—in particular, the strong red line λ6402, and less noticeably λ6143. By immersing the lamp in liquid air the effect was accentuated and also made to appear in the line λ6334.

Reference to the literature of the subject showed that some disagreement exists as to the wave-length of the line 6402, *e.g.*

Meissner	6402·246 Å.
Burns, Meggers, Merrill	6402·245 Å.
Takamine	6402·2392 Å.
Priest	6402·2395 Å.

Further, it was found that this line, together with a number of others, had been recorded as reversed by Meissner (*Ann. der Phys.*, 51, 1916) using a Fabry-Perot interferometer, and also by Perard (*Comptes rendus*, 1923), who deduced the reversal from the visibility of the fringes seen with a Michelson interferometer. Meissner interpreted the appearance as a reversal rather than as a doubling, since it seemed to vary with the thickness of gas traversed by the light. Reference to the Paschen series scheme for the neon spectrum reveals that all the affected lines are there classified as $1{\cdot}5S_m - 2p_n$, that is, they belong to the principal series, as we should expect if the effect is a genuine reversal. It seems, however, from the work of Hertz on the excitation potentials of neon (*Zeits. fur Phys.*, 22, 1924) that a better classification would be $2S_m - 2p_n$, with the quantum number 2 associated with the S_m states. Such a classification implies that it is absorption by excited neon which causes the reversal, this is borne out by some recent quantitative measurements by Meissner (*Ann. der Phys.*, Jan. 1925) and the results of Buisson and Jausseran (*Comptes rendus*, Feb. 1925). It thus seems scarcely possible to doubt that the lines are genuinely reversed, but it is surprising that with λ6402 the effect should be seen in a transverse view of a narrow capillary, as I have found to be the case.

The practical importance of the matter lies in the fact that the lines in question are rendered by this behaviour unsuitable for use as standards in work of the highest precision, since the effective wave-length is liable to vary with the experimental conditions. In cases where the resolving power is adequate to show the reversal clearly, the wave-length of the reversal could no doubt be safely used as a standard. For the wave-length of the reversal of λ6402 I find 6402·251 ± 0·001 Å.

The presence of the reversal and its remarkable fineness makes the line λ6402 especially valuable as a convenient "test line" for etalon adjustment. A 1 cm. etalon should just show it.

A list of the lines found by Meissner to be most affected is appended. It is unfortunate that it comprises most of the strong lines in the red and yellow regions.

Intensity	Wave-length.	Absorption
		(Per cent.)
25	5944 Å	50
45	6143	62
20	6266	49
35	6334	56
100	6402	74
60	7032	56

Some other lines are also affected, but not sufficiently, it is thought, to render them unreliable as standards.

W. H. J. CHILDS.

King's College, Strand.

The Fate of the Cyst of Monocystis in the Avian Gut.

TEXT-BOOKS do not tell us whether the cyst of Monocystis can pass unbroken through the gut of the bird which eats the lumbricid-host.

With the view of elucidating this point, I fed earthworms with wheat to a Rhode Island Red hen for three days; the fæces examined revealed the presence of a few separate pseudonavicellæ and one complete cyst.

VLADIMIR IGNATIEFF.

S.E. Agricultural College
(University of London),
Wye, Kent,
February 23.

The Dinosaur Region in Tanganyika Territory.

By C. W. HOBLEY, C.M.G.

THE expedition despatched to Tanganyika Territory in 1924 to explore the occurrence of dinosaur remains has recently attracted a considerable amount of public attention, for the fossil-bearing deposits are being successfully worked and a considerable amount of material is now on its way to the British Museum. It may, therefore, be of interest to describe the area in which the finds were made. From Kenya Colony southwards, through Tanganyika Territory to Portuguese East Africa, the framework of the eastern portion of the continent is composed of an extensive series of ancient metamorphic rocks, mainly gneisses and schists, and often intersected by pegmatite veins. In some parts these rocks stand out in a series of bold mountain ranges alternating with flat plains; in other parts the mountain ranges are only represented by isolated peaks and rocky kopjes called *Inselberge* by German geologists.

On the eastern flank of this old land surface a series of sedimentary rocks are found, varying in age from Permo-Carboniferous or Karroo up to Tertiary, and it is in this strip of country that the beds carrying dinosaur remains are found.

The Karroo beds need not detain our attention, for although of great general interest on account of their being the coal-bearing series of South Africa, they are poorly represented in this region, and dinosaurs had in those times not yet made their appearance on the scene.

South of the Rufiji river in Tanganyika Territory there is a large area widening out southwards towards the Rovuma. This is covered with a varied range of sedimentary rocks of Secondary age dating from the Upper Jurassic, and containing representations of the Wealden beds and the Cretaceous, and so on, up to some Tertiary deposits the exact position of which is uncertain. The presence of these beds is evidence of a series of invasions of the sea alternated by periods of elevation and erosion. By great good fortune Nature has preserved for us in these beds the remains of some of the most curious and at the same time the biggest creatures which ever peopled this earth. There are three beds bearing saurian remains, the two lower being referred to the Upper Jurassic and the top one to the Wealden period. Information has recently also come to hand of the discovery of deposits in northern Nyasaland, which also carry saurian fossils, and although detailed information is scanty at present, it may mean that the habitat of these ancient monsters will be proved to be of much greater extent than was previously expected. Maybe these deposits formed a continuous sheet over this part of Africa before the Rift Valley subsidence in Tertiary times.

Why this region was so well suited for these creatures, and what the conditions were which enabled them to exist in such numbers, are very intriguing questions, the answer to which is not readily forthcoming; only lengthy and extensive research will afford data necessary for any definite opinion. So much for the past, and some will ask what the country is like to-day. In physiographical terms, it is a dissected plateau having a maximum height of about 2500 feet, of which only comparatively few patches remain. To the east and north-east it slopes gradually coastwards, and on the west side it descends abruptly to the old metamorphic floor. The principal areas of more elevated country which indicate the former land surface are the Makonde, Rondo, Mbwala, and Ngarama plateaux.

In the neighbourhood of the river valleys cliffs are sometimes seen, due to the unequal erosion of beds of varying hardness, and we thus get forms which remind one of the *butte* or *mesa* of North America.

One of the latest phases of earth movement in this part of Africa was a depression, for the mouths of the rivers are submerged valleys. Permanent water is found in the main rivers, but in the network of tributaries, which help to determine the topography, the supply of water is exiguous, the rocks are generally very porous, the torrential but short spring rains produce a temporary rush of water, which rapidly soaks away during the ensuing long dry season, leaving only a few brackish pools to form breeding places for myriads of mosquitoes.

It is a depressing country to travel through, or to work in: for it is covered from end to end with the monotonous and typical bush which mantles so many thousands of square miles in eastern Africa. This bush country is here locally known as the *pori*, farther north it is called the *nyika*, and it is composed of an assemblage of acacias and wait-a-bits, interspersed with various kinds of xerophytic shrubs, with aloes, sansevieria, and euphorbias, encephelartos (a zamia), and that characteristic African monstrosity, the baobab. It is not uniformly dense, in fact, there are large stretches of country of an orchard-like character and carrying a rank growth of grass among the trees, and in such places a certain amount of game may be seen. The course of the rivers is often marked by a belt of fine trees, mimusops and such like, also phœnix palms.

The plant assemblage is a reflection of the meteorological conditions, for once we leave the actual coast line the rainfall becomes steadily less. The rainfall at Lindi is 32·7 inches; twenty miles inland it would probably be about half the amount, and the bulk of it will fall within about a couple of months or so. All along the east coast the small extent to which the monsoon rains affect the zone of the country for about 200 miles inland is a remarkable phenomenon. The moisture-bearing clouds do travel inland, but the hot air rising from the great belt of bush country appears to inhibit precipitation except where the clouds strike a mountain range; the cooler mass then causes some of the moisture to fall thereon, but the bulk sweeps on until it strikes some high plateau far inland.

As might be expected, such rigorous natural conditions have not made for great human progress or dense associations of human beings. A heterogeneous collection of people is scattered about on the flanks of the river valleys and on the higher parts of the plateau. They are all what is known as Bantus, the principal tribes found in the area being the Wa-Mwera, Wa-Makondé, Wa-Yao and Wa-Ngindo, Wa-Ngoni and Wa-Makua.

The Angoni, as is well known, are representatives of the great northward migration of part of the Zulu race,

which took place somewhere about 1825; it did not reach this region, however, until considerably later, and did not lead to a very extensive settlement; the Yao have also come from the south-west during the last fifty to sixty years, not in mass, but as a peaceful penetration, they are a virile race, and their arrival is a desirable thing for this region.

These coastal lands have been the scene of raids and counter-raids from time immemorial. In mediæval times they were swept by the irresistible Ma-Zimba, and later were ravaged by Arab slave traders from Zanzibar, then came the German occupation, and in 1905–6 the people rashly took an active part in what is known as the Maji maji rebellion, which was ruthlessly crushed by the Germans, and it is said that some 120,000 natives perished. In the War the area was the scene of desperate fighting between the Germans and the British expeditionary force, all peaceful development being necessarily suspended for the period of this struggle. The Tanganyika administration is, however, now endeavouring to improve the economic condition, but it is a slow and tedious work

The women of the Mwera, Makonde, and Makua tribes affect an extraordinary ornament called the *pelele*; the upper lip is pierced, the hole is gradually enlarged, and eventually a wooden disc, often as much as two inches in diameter, is inserted and worn. In addition, the lower lip is sometimes pierced and a peg or pin of bone or iron is suspended from it The origin of this curious custom is not certain, but the coast people assert that it is of recent origin and was done to prevent the women being carried off by the slave traders, for one so mutilated had little value in the slave market If this explanation is correct, it is curious to find the practice persisting to the present day; this generation will, however, see it disappear. The Yaos never adopted it; their women, however, pierce the side of the nose and insert a stud of wood ornamented with inlaid specks of white metal and called the *chipini*.

Vigorous native communities can only develop where natural conditions are favourable, in an area of natural fertility and abundant water supply. In the whole of the wide strip of bush land behind the east coast of Africa, from Kenya Colony to Portuguese territory, the conditions are very rigorous The soil is fertile, but the rainfall is exiguous, and the permanent water supplies are scanty; years of drought are more common than seasons of plenty. The people become to some extent seasonal migrants, and the development of large settled communities is impossible. How can they form large villages when in the dry season it may be necessary for the women of a village to make a journey of two hours to fetch water from a filthy water-hole for cooking and drinking purposes? Little wonder also that, when they are lucky enough to harvest a good crop, they convert too great a proportion into beer, have orgies to celebrate their good fortune, and fail to lay by enough for the inevitable shortage which will ensue. The unhealthiness of the country, moreover, cannot fail to have an unfavourable effect on their vitality, for they are perpetually exposed to the onslaught of the Anopheles mosquito; their huts are infected with Ornithodorus ticks; the bush is tsetse-ridden; and the stagnant water supplies infect them with intestinal parasites. Even leprosy is not uncommon. These natives are, however, no lower in natural intelligence than those of other portions of Africa, and, when taken out of their squalid surroundings and trained under European influence, they are proved to be capable of considerable mental development; in their homeland their environment weighs them down

Such is the land in which these wonderful fossil remains occur, and it may be gathered that their detailed exploration is not an easy task or one which can be hurriedly carried out. During the rains the vegetation spreads with great exuberance; foliage appears with a rush, the growth of the grass and the tendrils of creepers being remarkably rapid. The mantle of vegetation is so dense that all prospecting work for new outcrops has to be suspended. In a month or two all this beautiful greenery withers, very soon the grass fires begin, and the scene is changed from one of beauty into a blackened waste. The shade temperature rises to more than 100°, the nights become hotter, so that only hardened, devoted men can maintain their working energy under such arduous conditions.

This picture of the conditions to be encountered is not intended to deter, but to demonstrate that the task of thoroughly investigating this momentous discovery is one which requires the careful organisation of a team of workers, well fed and well looked after, and if possible all anxieties regarding transport and supplies should be taken off the shoulders of the technical staff. In this way results of the utmost value will assuredly be obtained.

Sex-Determination.

By Dr. F. A. E. CREW.

SEX is the term used to define the differentiation of individuals for the production of dissimilar gametes—the ova and the sperm. A male is an individual efficiently equipped for the elaboration of functional spermatozoa and for the conveyance of these towards the site of fertilisation A female is an individual equipped for the elaboration of functional ova, for the conveyance of these towards the site of fertilisation, and often also for the transit of the zygote —the fertilised egg—at some stage of its development to the exterior. Associated with these differences in the internal and external reproductive organs there are others in the general characterisation, the phenotype, by which male and female can be distinguished on inspection. Further, the sexes can be distinguished by differences in the chromosome constitution of the cells of which the individual is built up.

During the process of cell division, changes occur in the nucleus of the cell by which the contained chromatin material resolves itself into a certain number of filaments of definite shape, and these become progressively shorter to assume the form (in many cases) of stout rods —the chromosomes—which arrange themselves on the equator of the spindle. The number of chromosomes

is constant in and characteristic of the species to which the individual belongs. In certain stages of cell activity the chromosomes group themselves to form a characteristic arrangement and it can then be seen that they are associated in pairs, the members of each pair being identical in size and shape.

With the exception of one pair, the chromosome picture is similar in both sexes In one sex this exceptional pair consists of equal mates, whereas in the other there is one chromosome similar to these, but its mate is either unequal or absent. Since the sexes differ chromosomally in this way, the exceptional chromosomes are referred to as the sex-chromosomes; and of these, those similar in size and shape are known as the X-chromosomes; the unequal mate of the X in the one sex is known as the Y-chromosome. The chromosomes other than the sex-chromosomes are known as the autosomes, and are identical in both sexes. One sex is Xo or XY, the other is XX in sex-chromosome constitution.

It is an established fact that in each gamete—the mature reproductive cell—only one member of each pair of chromosomes is present. In the case of the one sex each will possess one half set of autosomes and one X-chromosome (1A + 1X); in the case of the other sex there will be two kinds of gametes, those that carry 1A + 1X and others that bear 1A alone or 1A + Y In the mammal it is the male that elaborates two kinds of gametes, the X-bearing and the no-X or Y-bearing, while the female elaborates but one; in the case of the bird it is the female that is hetero- or di-gametic and the male that is homogametic, elaborating but one kind of sperm so far as the elements of the sex-chromosome organisation are concerned. In the case of the mammal an X-bearing egg can be fertilised either by an X-bearing or by a no X-bearing sperm. In the former case an XX zygote will result having the typical female sex-chromosome constitution, in the latter an Xo or XY zygote will result having the typical male sex-chromosome constitution.

It has not only been shown that there are in certain cases demonstrable differences in the chromosome content of the two sorts of gametes elaborated by the heterogametic sex, but also in many mammals, by measuring the length of the sperm-head, it has been shown that there are two intergrading size-classes; it is suggested that the larger sperm is the X-bearing—the female-determining.

The chromosome theory of heredity assumes that all hereditary characters are determined by genes, and that these are resident in the chromosomes, each having its own particular locus in a particular chromosome. The facts that emerge from the study of the mode of inheritance of the so-called sex-linked characters force an adherent to this theory to the conclusion that the genes for such characters are resident upon the X-chromosomes, and that other genes, some on the sex-chromosomes and some on the autosomes, are directly concerned in the determination of the characters maleness and femaleness.

It is an established fact that the heterogametic individual receives its single X-chromosome from its homogametic parent and that the homogametic individual receives one X from each of its parents. If, then, on the single X-chromosome of the heterogametic individual is borne the gene for a recessive character, it becomes possible to follow the distribution of this X-chromosome by tracing the inheritance of the character. Experimental breeding involving a recessive sex-linked character has shown that, in its transmission from generation to generation, it is bound up in a most intimate way with some mechanism by which the sex of the zygote is determined A recessive sex-linked character of a heterogametic male will be exhibited by none of his children and by none of his granddaughters but by half of his grandsons, a recessive sex-linked character of a grandmother will be exhibited by none of her children or grandsons, but only by half of her granddaughters.

These facts can most readily and most satisfactorily be interpreted by postulating that the genes for sex-linked characters are resident in the X-chromosomes and also that the X-chromosomes carry genes that are concerned in the determination of sex. The conclusion also emerges that the sex of the zygote is decided by the simplex or the duplex condition of some component which, when present in duplicate, leads to the establishment of femaleness in the mammal and maleness in the bird. The evidence suggests that there is a sex-determining mechanism, an XY mechanism; that the sex-chromosome constitution of the male is Xo or XY in the mammal, and XX in the bird; and that of the female XX in the mammal and Xo or XY in the bird.

In the two sexes the ratio X-chromosomes : autosomes is different, and thus suggests that sex determination is not merely an affair of the sex-chromosomes but is also decided by the balance between X-chromosomes and the rest. In the mammals 2X · 2A (where A stands for one complete set of autosomes) is associated with femaleness, 1X : 2A with maleness This contention finds support in the facts of balanced intersexuality in *Drosophila melanogaster*, in which the ratio 2X : 2A is associated with complete femaleness, 1X : 2A with complete maleness, and 1X : 1·5A with pronounced abnormality in the sexual characterisation.

Since the difference in the sex-chromosomes is the only apparent difference in the genetic constitution of the sexes, it follows that in the mammal the X, or something lodged in it, is female-determining, while male-determination is an affair of the rest of the chromosomes. It is reasonable to assume that maleness and femaleness are characters in the modern Mendelian sense, being based on male-determining (M) and female-determining (F) factors resident in the chromosomes, and that in the mammal the female-determining factors are resident in the X-chromosomes and the male-determining elsewhere. In the bird it must be assumed that in the X-chromosomes are resident the male-determining factors. The situation thus arises that in the mammal,

(FX)(FX)M is an XX individual, a "determined" or "genotypic" female,

(FX)M is an XY individual, a "determined" or "genotypic" male,

whilst in the bird

(MX)(MX)F is an XX individual, a "determined" or "genotypic" male,

(MX)F is an XY individual, a "determined" or "genotypic" female.

By genotypic is meant according to the genotype—the sum total of the genes in the hereditary constitution of the individual.

At the moment when its sex is determined, the individual is but the fertilised egg. The sexual characters that will define and distinguish it are yet to be expressed Growth and differentiation precede characterisation, but in the main the characters of the mature individual are simply the expression of the genotype. Before the genotypic male becomes the phenotypic male—an individual equipped to function as the elaborator of sperm—the complicated processes of sexual differentiation must be pursued. It is assumed that these processes are directed by genetic action, that the genes—whatever they may be—elaborate specific chemical substances which model and direct the development of the individual. It is assumed that the sex-determining genes elaborate specific sex-differentiating substances—male-differentiating and female-differentiating respectively—and that these provoke responses especially in the developing structures of the sex equipment of the individual

During the development of the mammal there is a period during which the differentiation of the sexual organisation is timed to take place. At the beginning of this period, which follows a preliminary phase of growth and organ formation, the reproductive system consists of (1) paired gonads of indifferent histological structure, (2) a rudimentary accessory sexual apparatus composed of Mullerian and Wolffian ducts; (3) external genital organs represented by the growing urogenital sinus and genital tubercle From this initial type of reproductive architecture possessed in common by all individuals, determined male and female alike, one or other type of differentiated sexual organisation, male or female, is attained. The indifferent gonads become either testes or ovaries; if they become testes then the Wolffian ducts continue their development to become the functional deferent ducts of the testes, while the further development of the Mullerian ducts ceases and the external genitalia become scrotum and penis. If the indifferent gonads become ovaries, the Mullerian ducts continue their development to become the functional uterus with cornua and vagina, while the development of the Wolffian ducts ceases and the external genitalia assume the form of vulva and clitoris. Sexual differentiation is alternative, and the end-product is an organisation appropriate to the functional female or else to the functional male.

Between the differentiation of the various structures of the sex-equipment there is a time relation. The first structure to begin its differentiation is the gonad. The results of castration and gonad-implantation have shown perfectly clearly that in the mammal the differentiated gonad is necessary for the appropriate differentiation of the rest of the sex-equipment. In the presence of functional testicular tissues, the sexual organisation appropriate to the functional male is assumed; in the presence of functional ovarian tissues, that appropriate to the functional or phenotypic female. Such differentiation is pursued under the control of specific male and female sex-hormones, elaborated by the testis and ovary respectively. It is necessary only to explain the differentiation of the embryonic gonad in order to explain the complete assumption of the sexual characterisation.

This can be done if it is assumed that the gonad in its indifferent stage is ambivalent as regards its future mode of differentiation (though not completely so since its tissues as regards chromosome constitution are genotypically either male, Xo or XY, or female, XX), and that this differentiation is pursued under the direction of male-differentiating and female-differentiating substances elaborated by the male-determining and female-determining factors respectively. In the genetically-determined male, (FX)M, of the mammal, it is the rule for the male-differentiating substances to be effectively in excess over the female-differentiating substances, $1F < 1M$, during that period of development when the differentiation of the gonad is timed to take place, whereas in the genetically determined female, the female-differentiating substances are effectively in excess during this period, $2F > 1M$ In the case of the bird the relations of M and F are reversed. In the male, (MX)(MX)F, $2M > 1F$, and in the female, (MX)F, $1M < 1F$.

As a direct result of genetic action the male becomes possessed of testes, the female of ovaries The gonads become differentiated and the sex-hormones are liberated These sex-hormones, testicular or ovarian respectively, reinforce the maleness or the femaleness of the individual and direct the differentiation of the rest of the sex-equipment, as the constituent structures of this attain the appropriate degree of growth and become capable of responding to the stimulus of the appropriate sex-hormone. The genotypic male develops testes because he is a genotypic male. he becomes a phenotypic male because he has developed testes. The genotypic female develops ovaries because she is a genotypic female, she becomes a phenotypic female because she has developed ovaries In the insect the situation is different The gonad plays no part in sexual differentiation and the phenotype is based directly on the genotype

Recent work has shown that the "efficiency" of the sex-determining factors differs in different cases; some elaborate their sex-differentiating substances at a quicker rate than others, or come into action earlier. There are quickly elaborating and relatively slowly elaborating male-determining and female-determining factors. This conception can be illustrated by assigning arbitrary numerical values to these factors. M_1, M_2, M_3, M_4, and so on, and F_1, F_2, F_3, F_4, are male-determining and female-determining factors of relatively different efficiencies Different combinations of such factors are possible. In the mammal a genetic male is an XY (or Xo) individual. On the X-chromosome are resident the female-determining genes, on other chromosomes are the male-determining genes, symbolised as F and M respectively, and these may be F_1 or F_5, M_1 or M_4, according to the genotype of the parent from which each was received.

The situation can thus arise in which in the genotype of such a male there may be a combination of male- and female-determining factors, in which, though in the end 1M would be greater than 1F, yet because the female-determining factors were relatively quickly-elaborating and the male-determining genes relatively

slowly-elaborating (F_8, M_1, for example), the female-differentiating reactions would be in efficient excess during the earlier stages of the period of sexual differentiation. Hence, if the differentiation of the gonads is not a matter of a moment but occupies a certain amount of time, the whole or a part of their differentiation would be pursued under the direction of the female-differentiating reactions and ovarian tissues would be laid down. Later, when the male-differentiating reactions had ultimately overtaken and replaced the female-differentiating, if differentiation is not complete, the rest of the differentiation of the gonads would be into testicular tissues, so that a condition of "glandular" hermaphroditism would result. Since the type of the differentiation of the rest of the sexual characterisation is modelled by the kind of gonadic tissue present, this could lead to a marked degree of hormonic intersexuality

This conception can accommodate the now established fact of the assumption by a genotypic female of the sexual characterisation of a functional male and vice versa. The sex-chromosome constitution does not necessarily correspond with the sexual characterisation. It is not the sex-chromosomes that finally determine sex; it is the sex-determining gene-complex, and disharmony among the elements of this may be such as must lead to the assumption of a totally inappropriate sexual characterisation. Further, the situation is created in which environic agencies provoking disharmony can lead to intersexuality and even to sex reversal, which is not the transformation of a female into a male or vice versa, but merely the assumption by an individual genotypically of one sex of the sexual phenotype usually associated with the opposite: genotypically the individual remains unchanged. If sex reversal overtakes an individual of the heterogametic sex, it will continue to elaborate two kinds of gametes even though it functions as an individual of the sex which usually is homogametic, and this fact will be evidenced by the sex-ratio among its offspring. The sexual characterisation of an individual can be classified as (*a*) *Primary genotypic characters* (the sex-determining factor complex, usually defined by the sex-chromosome constitution, XY or XX) (*b*) *Secondary genotypic characters* (the sexual phenotype) These include the *Primary gonadic characters* (ovarian or testicular organisation of the gonads) In the insect all the sexual characters are secondary genotypic. In the case of the bird and mammal some are (*c*) *Secondary gonadic characters* (depending for their expression and maintenance upon the activities of the functional gonads)

Obituary.

PROF JAMES WARD

BY the death of Dr James Ward, Cambridge has lost one of its most distinguished teachers and British philosophy a man who by general acknowledgment was, along with the late Mr F H. Bradley, one of its leading figures. He passed peacefully away on March 4, at the advanced age of eighty-two years, universally beloved and respected, retaining to the end his intellectual vigour, and continuing his work in the University until the illness of his last few days compelled him to desist The January numbers of *Mind* and the *Hibbert Journal* contain articles from his pen which show that he had lost none of his critical alertness, while two years ago he published an elaborate "Study of Kant," the result of long and sustained research. Until a few months before he died, he was contemplating writing a comprehensive volume on epistemology; as a matter of fact, he had written some chapters of it, a series of articles he contributed to *Mind* during the years 1919 and 1920 constituting one of them.

James Ward was born at Hull on January 27, 1843. The home of his parents was, however, in Liverpool. Here he spent his school-days, and, on their termination, he was articled to a firm of architects. But he soon abandoned the idea of following a business career, and entered Spring Hill College to prepare for the work of the Christian ministry. For a period of twelve months he actually was minister of the Congregational Church at Cambridge. Then he discovered that his theological views were out of accord with those of the members of his congregation, resigned his charge, and entered Trinity College, where he came under the inspiring influence of Henry Sidgwick. He was already a graduate and gold medallist of the University of London, and was placed alone in the first class in the Moral Sciences Tripos of 1874, being elected a fellow of Trinity in the same year In his fellowship dissertation on "The Relation of Physiology to Psychology" there can be traced the germs of many of the principles he afterwards worked out in detail

Ward then proceeded to Germany, where he studied under Lotze at Gottingen and under Ludwig at Leipzig. Of both these teachers he always spoke in terms of the warmest admiration, and there is no doubt he was greatly influenced by Lotze in reaching his own philosophical position He was appointed lecturer in moral science at Cambridge in 1881 For many years he devoted himself chiefly to psychology, and it was under his guidance that Cambridge gradually became a centre of psychological research He was instrumental in starting a Psychological Laboratory almost about the same time that Wundt began experimental work in Leipzig Bringing to the study of psychology a wide and thorough knowledge of biology and physiology, he was enabled to interpret the facts of mind with the aid of evolutional conceptions in a way that had never before been attempted. Michael Foster used to tell him that he was a "physiologist spoilt", but he certainly atoned for his desertion of one science by completely revolutionising another.

Croom Robertson was to have written the article on "Psychology" for the ninth edition of the "Encyclopædia Britannica," but was prevented from doing so through failing health. Ward undertook to provide the article; he began writing it in 1884, incorporating the substance of certain papers of his which had already appeared in periodicals, and it was completed in 1885. A supplementary article was prepared by him for the tenth edition of the Encyclopædia in 1885; and finally,

in 1908, these with omissions and additions were amalgamated into the new article of the present or eleventh edition. Probably no article in the "Encyclopædia Britannica" has ever occupied quite the position in the history of a science that this does in the history of psychology Its original appearance marked the beginning of an altogether new departure in psychological investigation. Ward broke away entirely from the traditions of the associationist school then prevalent in Great Britain; and developed a conception of the mental life that has been immensely fruitful in later psychological work He propounded a view of the conscious subject as a centre of selective activity that gradually differentiates presentations of the objective world and thus builds up its world of experience On almost all the main problems of psychology new light was thrown, the treatment of attention, perception, imagination, feeling and conation was essentially fresh and original, and it has entirely superseded the older mechanical method of handling these subjects It is indicative of the thoroughness with which the foundations were laid that, when a quarter of a century later the work was revised for publication in the form of an independent treatise, little was found of a fundamental nature to alter The volume entitled "Psychological Principles," which appeared in 1918, contains much additional material, particularly the chapters which deal with the consciousness of self, but the general viewpoint remains unchanged.

In 1897 Dr. Ward was appointed to the chair of mental philosophy and logic at Cambridge. During the previous year he had begun the delivery of a course of Gifford Lectures at Aberdeen, which led to the publication in 1899 of his important work on "Naturalism and Agnosticism." These lectures contain a wonderfully lucid and penetrating analysis of the underlying principles of physical science and a remorseless exposure of the inconsistencies of Herbert Spencer's attempt to base a philosophy of evolution on the principle of the conservation of energy. In the second volume of the book the doctrine of psychophysical parallelism was examined, and it was maintained that the assumption of a dualism between mind and matter renders not only the connexion of body and mind an enigma for the naturalist, but also the problem of the perception of an external world equally intractable to the psychologist If, then, materialism be abandoned and dualism be dismissed as untenable, there remains only, it was urged, a spiritualistic monism as the one secure philosophical position. The ground was thus prepared for a more constructive effort; and when, ten years later, Prof Ward was invited to give a further course of Gifford Lectures at St Andrews, he entered upon the task of trying to determine what we can know, or reasonably believe, concerning the constitution of the world, interpreted throughout and strictly in terms of mind

The lectures were published in 1911, under the title of "The Realm of Ends, or Pluralism and Theism" The start was made from the consideration that the world immediately confronts us not as one mind, or even as the manifestation of one, but as an objective whole in which a multiplicity of minds are discerned in mutual interaction. From this pluralistic point of view our experience has in fact developed, and from it the ideas are acquired that eventually lead beyond it. For, though empirically warranted, pluralism, it was argued, turns out to be metaphysically defective and unsatisfactory; it points to a theism which is indeed only an ideal, but an ideal that, as both theoretically and practically rational, may claim our faith though it transcend our knowledge. Ward worked out, in fact, a system of monadology resembling that of Leibniz, except that the doctrine of pre-established harmony was entirely discarded, and the monads were conceived as interacting.

Ward's position in the history of philosophical thought is, beyond a doubt, firmly established. But those who knew him as a friend will be chiefly mindful at this time of his strong and beautiful personality. His wide and accurate scientific knowledge, his love of Nature, and his interest in all that contributes to human good, made him a delightful companion. He could tell the name of every wild flower to be met with in a country walk, the habits of any bird or insect which he chanced to come across, and he would take one back to his home and show with boyish pride the rare collection of birds' eggs he had made in his youthful days. No scholar ever bore his weight of learning more lightly. He would converse, too, when the occasion offered, on the deeper problems of life with the sincerity of a man who was continually wrestling with them, and with a modesty that was engendered by real greatness Of him his friends can truly feel that of all the men of their time he was of the small company of "the wisest and justest and best" G. DAWES HICKS

DR. HEINRICH OSCAR LENZ, the Austrian geographer, whose recent death at Vienna has been announced, was born in 1848. He first went to Africa in 1875 under the auspices of the German Africa Society to make a geological examination of the Lower Ogowe in the Gabun region In 1879 the same body sent him to Morocco with the view of exploring the valleys of the Atlas. In the face of great difficulties he made a remarkable journey across the Sahara by way of Tarudant, Tenduf, and Arawan to Timbuktu and thence westward through Senegal to the coast A great part of this journey was over new ground. It was described in his "Timbuktu · Reise durch Marokko" (1884). Lenz's later explorations, which were in the Congo basin, were of less importance. Sent in 1885 by the Vienna Geographical Society to obtain news of Emir Pasha, he ascended the Congo to Nyangwe, and striking eastward reached Lake Tanganyika and Ujiji. The traverse of Africa was completed by Lake Nyassa and the River Shire. For his African work Lenz received the gold medal of the Paris Geographical Society. For some years he was professor of geography at Prague.

WE regret to announce the following deaths:

Dr. André Broca, professor of medical physics in the faculty of medicine of the University of Paris, who was known for his work on physiological optics, on February 23, aged sixty-one.

Dr. William McInnes, formerly director of the Geological Survey of Canada and director of the Victoria Museum, Ottawa, on March 11, aged sixty-seven years.

Current Topics and Events.

THE British Institute of Philosophical Studies has been formed by a number of professed philosophers together with some leading men of science, public men, and men of affairs It is the belief of the promoters that philosophy has a larger part to play in the national life than has yet been recognised, both as an education and discipline to the individual, and as the basis of that more synthetic view of knowledge which they take to be the required corrective of the specialism enforced upon students by the rapid growth of science They think that, in the position which the physical sciences have now reached, the need of a philosophic account of principles and methods is more apparent than it may formerly have been, that there is accordingly more disposition on the part of scientific men to discussions which might, not long ago, have been dismissed as metaphysical; while the philosophers on their side have much to learn of the picture of reality as presented by modern physics It is considered also that on the side of human relations and social ideals the lack of a common basis is widely felt, and the promoters remember that the systematic exploration of such a basis is a part of the historic task of philosophy Recognising the existence of an excellent philosophical faculty in the University of London, the Institute will cater specially for the non-academic student, but this does not mean the casual visitant to more or less popular lectures Lectures with a wide appeal are certainly included in the plan, but the aim is rather to establish systematic courses extending over a considerable period, combining tutorial work or small discussion classes with more formal lectures, and providing for the direction of study, the writing and criticism of essays, and all that may enable a student to make a serious start in his subject The formation of a good philosophical library is an essential part of the scheme, and it is hoped that the drawing together of a number of philosophers, who are at present a somewhat lonely race, to co-operate in the advancement of their subject, may prove a stimulus and encouragement to original work, with which it is hoped that the Institute may be associated.

IN 1892 Dr. John Hopkinson, in his presidential address to the Junior Institution of Engineers, laid down the principles on which an equitable method of charging for the electric light could be devised Probably no subject has been more discussed by electrical engineers than his method of charging, and numerous modifications of it have been tried in practice. At the Institution of Electrical Engineers, on April 2, G. Wilkinson and R. McCourt read a paper describing a novel modification of Hopkinson's principle, that each consumer should bear his proportion of the cost of the standing charges as well as the cost of the number of units he uses. In several cities a two-part tariff is employed, which consists of a fixed charge based on the rateable value of the premises, and in addition a low price per unit for all the electricity used. The obvious criticism to this system is that the assessment of the building for rating purposes does not necessarily bear any relation to the consumer's demand The authors propose that each consumer should fix his own maximum demand for electrical energy So long as this maximum demand is not exceeded, then, if his consumption during the quarter exceeds a definite number of units, all units in excess of this amount would be charged for at a merely nominal rate On the other hand, if he ever exceeded his "maximum demand," all units expended during the time of overload would be charged for at the full rate A simple meter was described which records the charge automatically on a high-rate and a low-rate dial When a consumer was exceeding his demand one or more neon lamps fixed in suitable places were illuminated so that he knew that he was paying at the higher rate The system is, in our opinion, fairly equitable, but we think that most consumers would have a difficulty in understanding it and would have a suspicion that advantage was being taken of their ignorance

IN the discussion on the financial resolution in connexion with the Imperial Institute Bill which took place in the House of Commons on March 30, it was stated by a member that little appeared to have been heard of the actual work of the Institute It is therefore appropriate to direct attention to the principal publication of the Institute, namely, its quarterly Bulletin, which has now reached its twenty-third year of issue Each number of this quarterly contains results of investigations conducted in the laboratories of the Institute, articles and notes on the production and utilisation of Colonial and other raw materials, a summary of recent progress in agriculture and the development of natural resources, and notices of recent books dealing with such subjects In the number of the Bulletin just issued (vol 23, No 1) a new feature has been introduced consisting of a classified bibliography relating to Colonial development and resources This section should prove of great value to workers overseas The investigations at the Institute recorded in the present issue include the examination of the berries of a South African tree which yields an oil shown to be suitable for soap-making, the determination of the properties of balsa wood from British Honduras and monkey apple timber from Sierra Leone and a study of their possible uses; and an investigation of certain British Honduras woods as paper-making materials A third instalment of an article on the possibilities of cement manufacture in the Crown Colonies and Protectorates contains incidentally the results of examination at the Institute of various cement-making materials from Trinidad, the Bahamas, British Honduras, and Fiji. An article giving an account of the henequen or Mexican sisal hemp industry of Yucatan should prove of interest to planters in Kenya, Tanganyika, and other parts of the British Empire where the production of sisal hemp is of increasing importance

THE arrangement of the Science Exhibition in the Government Pavilion at the British Empire Exhibi-

tion, at Wembley, is this year in the hands of a Royal Society committee under the chairmanship of Mr. F. E. Smith The theme of the principal section of the physical exhibits is the subject of radiation and wave motion ; and the extended spectrum of electromagnetic oscillations and radiations, from slow oscillations and wireless waves at one end, through the visible region, to X-rays and γ rays at the other, has been taken as the basis of arrangement The exhibits will show the methods of generation and detection of radiation in the different regions and will illustrate the properties of the rays, and the essential correspondencies will be emphasised, *e g* selective absorption of visible rays will be compared with resonance and the tuned circuit in the wireless region A very large proportion of the exhibits will be working demonstrations Space will also be devoted to the work on atomic structure, where the exhibits will include models of the atoms Meteorology, terrestrial magnetism, and seismology will again be represented, and a working seismograph will be shown The arrangement of the sections of zoology, botany, and physiology will follow rather similar lines to that of last year, where the exhibits having a bearing on evolutionary theory were found to be extremely popular A revised edition of the Handbook is to be published, which will contain an introductory article by Sir Oliver Lodge Other new articles are by Prof G Elliot Smith on "The Human Brain," Mr C Tate Regan on "Darwinism," and Dr E J Allen on "Life in the Sea"

In our issue of February 21, p 276, we referred to the system of loan collections which is in operation at the Salford Museum and also at the American Museum of Natural History Such a scheme, we learn, has for twelve years been the basis of the "Lending Department" of the Newark Museum, Newark, New Jersey Born and raised in a public library building, this museum has adopted many of the ways of the modern library This has been all the easier as its Director, John Cotton Dana, is also City Librarian The Lending Department of the Museum, although open to the general public, is used almost entirely by the schools Its collections number more than 5000 objects, classified under 28 heads, of which the most important are life and customs, geographical, dolls in costume, and industrial process charts Science and nature study are also well represented Descriptive and illustrated matter accompanies most of the exhibits, which are made up according to requests and delivered to the schools three times a week—about 1500 objects a month. During 1924 more than 500 teachers in fifty out of seventy public schools used this Department The Museum's collections thus came under the eyes and hands of more than 30,000 children—most of them between the ages of nine and twelve, and representing a dozen different races Borrowing has been made as simple as in the library, and most of the objects may be kept for one month, with privilege of renewal. The popularity of this Department is the more notable because the Newark Museum is within an hour's ride of the great museums and collections of New York City

The services of preparators and laboratory attendants do not always meet with the recognition they merit It is therefore pleasing to note that the cross of the Légion d'honneur has been conferred on M. Henri Vigreux, "garçon de laboratoire" at the Paris Faculty of Sciences M Vigreux, who entered the service of the Sorbonne in 1895, suffered severely from the bursting of an apparatus for fractional distillation in 1898 He set himself then to improve the apparatus of the chemical laboratories and became highly expert in glass-blowing, inventing many pieces of apparatus and many methods of great value to chemists and physicists In 1919, having lost the left forefinger in another explosion, he travelled round the laboratories of the provincial universities teaching the craft of working in glass. M Vigreux has previously received the silver medal of the Société d'encouragement pour l'industrie nationale and the "grand-prix" of a recent exposition of craftsmanship

Nearly two years ago, complaint was made before the Intellectual Co-operation Committee of the League of Nations at Geneva that the Vienna Academy of Sciences was so impoverished as to be unable to publish its transactions At about the same date, extensive abstracts of its papers were published by *Die Naturwissenschaften* at Berlin For a year past Nature has reported at least the titles of papers read These have been taken from the *Anzeiger* pamphlets reporting each meeting The complete volume of *Anzeiger* for the year is now to hand (Akademie der Wissenschaften in Wien. Mathematisch-naturwissenschaftliche Klasse. Anzeiger 61 Jahrgang 1924, Nr 1 bis 27, pp. 209. Holder, Pichler, Tempsky, Wien, 1925) It will be valued as giving in a collected form reports which have been scattered through a number of small continued contributions. Such are the reports from the Handel-Mazzetti botanical expedition to China, the reports of the Radium Institut and the meteorological reports

The February weather map of the Dominion of Canada records some unusual features for the month. In all Ontario the mean temperatures were in excess of the normal, by 6°-10° F. in the region of the lower lakes and the Ottawa valley. The province of Quebec had the mildest February since 1877, and in many parts the ground was nearly bare of snow at the close of the month. In the maritime provinces last February was one of the mildest on record, with little or no wintry conditions after the first week In many parts the thin covering of snow on bare ground seriously delayed lumbering operations. In the prairie provinces and British Columbia the month was milder than usual, except to the north of the fifty-fifth parallel, where the mean temperature was considerably below normal. In the Yukon there was a deficiency of 8°-10°. Precipitation was generally deficient except in Quebec, part of southern Ontario, Vancouver Island, and the lower Fraser valley.

UNTIL further notice the Science Library, South Kensington will remain open until 8 P.M. on Thursdays and Saturdays After 6 P.M., entrance to the Library will be through the Imperial College of Science and Technology in Imperial Institute Road.

AT the meeting of the London Mathematical Society, to be held on April 23 at 5 P.M., in the rooms of the Royal Astronomical Society in Burlington House, Dr. Harold Jeffreys will give a lecture on "The Interior of the Earth." Members of other scientific societies will be welcome.

DR. F. W. ASTON, fellow of Trinity College, Cambridge, has been elected a member of the Athenæum under the provisions of the rule of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

APPLICATIONS for grants in aid of scientific investigations bearing on agriculture to be carried out in England and Wales are invited by the Ministry of Agriculture and Fisheries. They must be made upon a prescribed form (A. 53/TG) obtainable from the Secretary to the Ministry, Whitehall Place, S.W.1.

THE fourth course of training of seed analysts will be held in the summer of 1925, beginning on July 7, at the Official Seed Testing Station, Cambridge Particulars of the course can be obtained from the Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

A JOINT general discussion on "The Physical Chemistry of Steel-making Processes" is to be held by the Iron and Steel Institute and the Faraday Society on Monday, June 8, at the Institution of Civil Engineers, Great George Street, London, S.W.1. Sir Robert Hadfield, Bart., will deliver the introductory address, and a provisional programme of papers covering the various phases of the manufacture of steel has been issued.

PROVIDED works of sufficient merit are submitted, the second award of the Nichols prize of the Royal Society of Medicine, value 250*l*., will be made in 1927. The prize is open to British subjects for the most valuable contribution towards "The discovery of the causes and the prevention of death in childbirth from septicæmia." Competing essays must be typed or printed in English, accompanied by the names and addresses of the authors, and be submitted not later than October 1, 1927, to the Secretary, Royal Society of Medicine, 1 Wimpole Street, W.1.

IN our issue of January 17, p. 96, we expressed regret that such an old-established firm of optical instrument makers as that of Sir Howard Grubb and Sons, Ltd., of St. Albans, should have gone into voluntary liquidation. We are glad now to learn from Sir Charles A. Parsons that a new company, trading as Sir Howard Grubb, Parsons and Co., has purchased from the liquidator the goodwill, drawings, and sundry plant and machinery of the firm, and that workshops of up-to-date design are being erected at Heaton, Newcastle-on-Tyne, especially suitable for the building of large astronomical telescopes and observatory equipment. The advice and experience of Sir Howard Grubb will be at the disposal of the new company. All communications should be addressed to Heaton Works, Newcastle-on-Tyne.

THE Smoke Abatement League of Great Britain held a Conference in the Town Hall, Manchester, on November 3-6, 1924, at which a series of papers was read by persons interested. The papers and discussions have now been published in a handy volume (5*s*. 6*d*. post free) to be obtained from the Secretary, C. Elliot, 33 Blackfriars Street, Manchester. This symposium covers practically every aspect of the subject; the law and smoke; the measurement of air pollution; the effect of smoke on human life, vegetation, and buildings; smokeless fuels prepared by low and high temperature carbonisation, steam generation, electrical power supply; and lastly, the economic aspect of a smoky atmosphere Looking through the papers one is struck by the very diverse remedies prescribed by the advocates of different processes, and a general consensus can scarcely be obtained. Doubtless all will contribute a share, and the publication is certainly of value as bringing to a focus the many ideas which are expected to lighten the darkness of our industrial cities.

THE report of the National Physical Laboratory for the year 1924 is a quarto volume of 220 pages, 170 of which are devoted to accounts of the researches which are at present in progress in the Laboratory. These accounts are as a rule sufficiently detailed to allow the reader to understand the object of the research, the method adopted and the results which so far have been obtained. They are accompanied by illustrations which add considerably to their interest and their value. So far as the amount of testing work done during the year is concerned, there has been an increase since the previous year in all departments except those connected with engineering and shipbuilding. The need of new buildings for physics and electrotechnics has again been pressed by the Committee, and it is hoped that funds for them will be forthcoming at an early date A large proportion of the research work is undertaken for the Research Associations of the Department of Scientific and Industrial Research and for other Government Departments, and the rest is under the control of Sir Joseph Thomson, Sir Ernest Rutherford and Sir William Bragg, who visit the Laboratory from time to time.

THE after-Easter lecture session at the Royal Institution will commence on Tuesday, April 21, at 5.15, when Prof. J. Barcroft will begin a course of four lectures on "Some Effects of Climate on the Circulation." The Tyndall lectures will be delivered by Prof. R. Whiddington on the passage of electricity through vacuum tubes, commencing on Tuesday, May 19. On Thursday afternoon, April 23, Mr. F. Kingdon Ward will begin a course of two lectures

on exploration in Tibet. On succeeding Thursday afternoons there will be two lectures by Prof. H. J. Fleure on prehistoric trade and traders on the west coasts of Europe, and two by Prof F. O. Bower on the natural classification of ferns as a study in evolution. Mr. W P. Pycraft is to give two Saturday afternoon lectures on use and disuse and their effect on the bodily structure of animals The Friday evening meetings will be resumed on April 24, when Dr. W A. Craigie will deliver a discourse on the Icelandic Sagas Succeeding discourses will probably be given by Prof. W L Bragg, Dr H H Dale, Prof C G Darwin, Dr. Thorne M. Carpenter, Sir Henry Newbolt, and others.

MESSRS Negretti and Zambra, 38 Holborn Viaduct, London, E C.1, have issued a useful list of second-hand and shop-soiled instruments which they have for disposal The list contains, among other items, a useful selection of microscopes, pieces of surveying apparatus, and thermometers, while under "sundries" are offered projectors, barographs, aneroids, and so on. The list should be seen by all who are contemplating the purchase of apparatus

A VERY full and comprehensive catalogue (No 125) of second-hand botanical works has just reached us from Messrs Dulau and Co , Ltd , 34 Margaret Street, W 1. It contains 4439 titles conveniently arranged in the following sections . Regional Floras, Gardening and Horticulture, Fruit Culture, Sylviculture, Gardens and Landscape Gardening, Biology of Plants, Monographs, Biography, Bibliography, Terminology, Dictionaries, Manuals, etc , Herbals and Early Gardening, Cryptogamic Botany, Phyto-pathology, Geoponica, and Serial Publications.

THE Cambridge University Press will shortly publish Vol. 19 of the Royal Society's "Catalogue of Scientific Papers," covering the letters T to Z and completing the work. Another book to be issued by the same house will be "Aerial Surveying by Rapid Methods," by Prof B Melvill Jones, the main purpose of which is to discuss the possibilities of aerial photography as a means of surveying and mapping the earth, and to record and describe a series of experiments made at Cambridge by the author and the late Capt. J. C Griffiths.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned · a guide-lecturer in agriculture at the British Empire Exhibition —The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 25); an assistant lecturer in agriculture at the Agricultural Institute, Kirton, near Boston, Lincs —J C Wallace, at the Institute (April 30); demonstrators in physics and organic chemistry respectively, at Bedford College for Women, Regent's Park, N W.1—The Secretary (May 2), three assistant naturalists in the fisheries department of the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S W 1 (May 8), a woman lecturer in geography in the department of education of the University, Birmingham—The Secretary (May 16); assistant professor of zoology in McGill University, Montreal—The Secretary (May 20); an assistant professor of chemistry, of Egyptian nationality, at the Cairo School of Medicine—The Director (May 31)

ERRATUM.—In NATURE of April 4, p. 518, col. 1, line 14, the name of Mr Savin is printed incorrectly as Sairn.

Our Astronomical Column.

A SIMPLE INTERFEROMETER. — Probably many people are under the impression that interferometer methods are only possible with very large instruments. This is undoubtedly the case where measurement of stellar diameters is in question But a short paper by Mr L Richardson (Brit. Astron. Assoc Journ , Feb. 25) describes an application of the method that is within the reach of all amateurs This is a cardboard screen covering the object-glass with a number of parallel openings cut in it, the width of the closed spaces being made equal to that of the open ones. The card can be turned by strings from the eye-end about an axis in its own plane through its centre, and the amount of tilt read on a scale made of millimetre paper. Each star then shows a central image, and a series of diffraction images on each side diminishing in brightness. Turning on Castor (for example), the card is tilted until the distance between the principal and first diffraction image is equal to that between the two stars of the binary. The tilt of the card then gives a very good measure of the angular distance between the stars. Four measures of Castor give distances 4·57″, 4·56″, 4·54″, 4·59″. Since the images are short spectra, there is a liability to personality in the measures, but a single observer can obtain accurate relative results.

THE NEW WASHINGTON CATALOGUE OF FUNDAMENTAL STARS.—Prof. W. S. Eichelberger communicates to *Ast. Nach.* No. 5353 a paper on this catalogue, which will appear in full in vol 10 of "Papers of the American Ephemeris," a summary of results being given in the Ephemeris for 1925. It uses the results of two observatories only (the Cape and Washington), the Cape declinations are corrected by −0·15″ tan zenith-distance-north, as a result of a rediscussion of refraction The general result of the discussion is that the declinations in Boss P.G.C. need a nearly constant correction of about +0·47″ from 50° N. Decl. to 40° S. Decl.

Prof Eichelberger then turns to the new Greenwich catalogue for 1925 and notes that, while on the published figures it agrees better with Auwers than with the new Washington one, yet if two changes were made, (1) the use of his new proper motions in bringing up to 1925, (2) giving Venus equal weight with the sun in fixing the equator point, the Greenwich and Washington results would not differ much.

The errors in Boss's proper motions are ascribed to uncorrected systematic errors in the older catalogues that he employed. In the future it will probably be desirable to discard, at least for fundamental stars, all catalogues that rest on observations with instruments the division errors, etc., of which were not determined by modern methods.

Research Items.

SEX RATIOS IN AFRICA.—Capt. L. W G Malcolm has brought together in the *American Anthropologist*, vol. 26, No. 4, data from various sources, in addition to his own observations, bearing upon the question of sex ratios among the tribes of West Africa and other parts of that continent, with the view of ascertaining what relationship these ratios bear to racial decline or otherwise. In the case of the adult sex ratio there is, in the majority of cases, a low degree of masculinity. The preponderance of females over males, however, in many cases is due purely to artificial causes, such as intertribal warfare and slavery or forced labour, which have depopulated large tracts, especially in West Africa. The ratio is 89 80. For the sex ratio at birth the information is very scanty, but it appears to be somewhat lower than that of European countries. The suggestion that a surplusage of adult men over adult women of reproductive age is consistent with a corresponding decline in the crude population, and that an increasing population produces a surplusage of women, does not appear to be in accord with the observed facts The evidence for Africa is too scanty to indicate whether there is a higher proportion of male to female births in polygamous or monogamous marriages An appended note by Dr A S. Parkes suggests that the great excess of females among adults is produced by a high masculinity in the mortality, possibly due to an inherent frailty of males which is also apparent in European figures.

PLANKTON at CULLERCOATS —Plankton investigations occupy a large part of the report for 1923–24 of the Dove Marine Laboratory, Cullercoats, Northumberland, each group being dealt with both in the form of lists and tables. With such an amount of information available, the plankton of the Cullercoats area should soon be thoroughly known. Miss Jorgensen states in her report on the Crustacea that, whereas there are many more decapod larvæ taken from the inshore stations, the copepods were in much larger numbers farther out In her table, however, showing total copepods, she gives the largest average but one from Station 1, which is one of those closest inshore On carefully examining the detailed copepod tables, we find that this inshore maximum is chiefly due to Temora, a neritic copepod capable of living under very variable conditions. The bulk of Miss Meek's important work on pollution of the River Tyne is reserved for a separate memoir, only a short résumé appearing here in which she states that last autumn there was a good ascent of salmon, and the smolts passing to the sea in the spring were numerous, few having died in passing through the polluted area.

CHENOPODIUM OIL IN THE TREATMENT OF HOOKWORM.—In the *Journal of Pharmacology and Experimental Therapeutics* for December 1924, Drs. W. G. Smillie and S. B. Pessoa give an account of the anthelmintic properties of the various components of chenopodium oil, one of the drugs authorised by the International Health Board for use in campaigns against hookworm disease. The constituents of the oil were isolated for these experiments at the Wellcome Chemical Research Laboratories in London, and the authors show that the only vermicidal agent in the oil is ascaridole, which proved to be remarkably efficient against the two common forms of hookworm, *Ankylostoma duodenale* and *Necator americanus*, though the latter was more susceptible to its action than the former. Victims of hookworm disease in the tropics almost invariably harbour other helminths, notably Ascaris, in addition to hookworm, and ascaridole has the advantage over other hookworm remedies, such as thymol and carbon tetrachloride, of also eliminating Ascaris from the intestinal canal. In view of these results, the authors point out that if ascaridole itself proves too expensive for use in extensive campaigns against hookworm and it is necessary to resort to chenopodium oil, it is desirable that the dosage of the oil should be based on the amount of ascaridole in it If this precaution were taken, much of the risk attending the use of chenopodium oil, which like all effective anthelmintics is toxic to the host as well as the parasite, will be avoided The authors naturally do not refer to other remedies for hookworm, but there is now a considerable amount of evidence that a solution of ascaridole in pure carbon tetrachloride is probably the most effective remedy against joint infection by hookworm and Ascaris It has the great advantage of being cheap, a point of first-rate importance in such campaigns where the cases to be treated are numbered by hundreds of thousands

THE LEPIDOPTERA OF NEW YORK —Memoir 68 of the Cornell University Agricultural Experiment Station (June 1923) has recently come to hand, and is devoted to an account of the "Lepidoptera of New York and Neighboring States" The author, Mr W T. M. Forbes, is to be congratulated upon this very careful and detailed piece of monographic work. It extends to more than 700 pages, and deals with all the so-called Microlepidoptera and such families as the Saturnidæ, Bombycidæ, and Lasiocampidæ, etc., among the higher groups It is, furthermore, prefaced by a good illustrated general account of the external morphology of the order The wealth of information relating to family, generic and specific characters and the metamorphoses should prove of great value to the systematist, while at the end of the memoir there is a good index to the food-plants of all the larvæ referred to We shall welcome the appearance of the remaining portion of this work, which, when completed, will serve as a general book for reference

SEX-TRANSITION IN PLANTS —*Arisæma japonica* is an Aroid which has usually been regarded as strictly dicœcious, although American species may be moncœcious Tokujiro Maekawa (Journ Coll. Agric., Imp. Univ. Sapporo, Japan, vol 13, Part 3), in an interesting account of experiments with this plant, shows that the same corm is at first asexual, after one or more years develops a male inflorescence, and one or two years later becomes (and normally continues) female. The author collected 231 corms from which he demonstrated these phenomena of sex-transition. Occasionally retro-transition from female to male took place, but moncœcious inflorescences were rare and intersex conditions apparently did not occur Sex is here a progressive phenomenon in the individual correlated with the weight of the bulb, and believed to be dependent on the amount of formative assimilation products (*i.e.* size of leaves) rather than the amount of reserve material in the corm. It was possible to reverse the sex of a female corm by growing it in poor, sandy soil or by cutting off portions of the corm or leaves. In this way a corm which had been producing female inflorescences could be made to produce a male The relation of these results to other studies of sex-determination in plants is discussed at some length. Schaffner (*Amer Journ. Bot.*, vol. 9, p 72) has obtained similar results with American species of Arisæmas.

BROWN HEART IN AUSTRALIAN APPLES.—Reports 21 and 22 of the Food Investigation Board of the Department of Scientific and Industrial Research seem to show conclusively that this diseased condition of imported Australian apples results from the accumulation of carbon dioxide in the ship's hold during the voyage (see NATURE, vol 112, pp 636-7, October 27, 1923) Report 21 gives the results of the study of the atmosphere in ships' holds during the voyage by Messrs A J. Smith, Ezer Griffiths, and E A Griffiths In Report 22, Mr A J. Smith, the physiologist sent out by the Food Investigation Board to Australia, presents the results of his investigations of conditions in the orchard and during the handling of the apples up to the time of shipment No signs of brown heart were discovered in the fruit prior to shipment, nor was the treatment of the fruit likely to produce the disease On the other hand, the concentration of carbon dioxide in unventilated ships' holds often rose above the safety limit of 10 per cent during the voyage, and shipments examined on arrival showed marked correlation between occurrence of brown heart and high carbon dioxide contents recorded on the voyage.

A NEW DEVONIAN ECHINOID —A new genus of echinoid (Nortonechinus) from the Upper Devonian of Iowa is described by A O Thomas (Iowa Geol Survey, 19, p 481) The genus shows several features of interest, and the great rarity of echinoids in the Devonian system gives importance to this discovery Nortonechinus appears to be allied to Archæocidaris, but differs from it in having 11, or possibly 14, columns of plates in each interambulacral area instead of 4 ; and the imbrication of the plates is more considerable, so that the test must have been very flexible The spines are remarkable for the great expansion of their distal ends, so that they became polygonal by mutual contact, and must have formed a coat of mail over the test similar to that seen in the living species *Colobocentrotus atratus* , this feature has been hitherto unknown in Palæozoic echinoids except to a limited extent in Xenocidaris Parts of the lantern have been found and seem to be similar to those of modern cidarids

THE GEOLOGY OF SOUTHERN RHODESIA —A very valuable summary by H B Maufe of the physical features and geological formations of Southern Rhodesia appears in the first "Official Year-book" of the Colony, and is conveniently reprinted as a Short Report (No 17) of the Geological Survey. The report is accompanied by an excellent colour-printed geological map, and the history of the region is well set forth in a provisional table of formations which also gives the associated igneous intrusions, earth-movements, and economic minerals Unfortunately no fossils have been found in any beds older than those of the Karoo system. Even where fossils do occur, they are wholly terrestrial, the sea never having invaded the Colony since at least Carboniferous times. The Glossopteris flora is represented in the Wankie coalfield, while the Upper Karoo has yielded remains of dinosaurs and of petrified wood The younger Kalahari contains freshwater shells and the plant Chara The older rocks can be correlated lithologically with corresponding systems in South Africa, but in neither area has it yet proved possible to correlate with standard equivalents elsewhere. The discovery of uranium minerals would probably help in determining the position of one or two of the unfossiliferous formations Already, indeed, the uraninites of Morogoro and Katanga may be used in this way. They are clearly of Upper pre-Cambrian age, and if the lithological correlations can be trusted, the Transvaal System (sometimes thought to be Ordovician from the occurrence of a doubtful fossil in Angola) should be, as Prof. J. W. Gregory thinks, nearly equivalent to the Torridonian or Longmyndian in Britain.

PRECAUTIONS AGAINST TROPICAL CYCLONES —The recent quarterly number of *Matériaux pour l'Étude des Calamités* contains an important article by Mr. Stephen S. Visher on tropical cyclones as calamities (No. 3, 1924, pp 195-217) Most of it is devoted to a description of typhoons, their principal centres of origin, their seasonal distribution and frequency, and the courses followed by typhoons. In the concluding pages, he suggests several methods of reducing the damage done by them. Houses should be built of reinforced concrete and about twenty feet above the sea-level or the bottom of a valley. Coastal cities should be protected from hurricane waves by sea walls like that at Galveston, U.S., where six thousand lives were lost during a typhoon in 1900 Crops should be diversified, so that all is not necessarily lost at one blow The taller growing varieties of bananas should be replaced by the dwarfed Chinese kind, and indiarubber plantations should be grown in sheltered valleys Weather offices should be established in the stormier regions, so that sufficient notice of an approaching typhoon may be given by radio or telegraph to allow the strengthening of buildings or the removal of livestock and boats from the lowlands.

TEMPERATURE RECORDS AT WILLIS ISLAND.—We have received from Capt E. Kidson, of the Meteorological Bureau of the Commonwealth of Australia, a note on a paper on "Observations from the Willis Island Meteorological Station" which was read at the meeting of the Australasian Association for the Advancement of Science in Adelaide in August 1924, together with copies of two weekly thermograph charts The island offers useful opportunities for research into the meteorology of the trade winds, being in lat 16° 18′ S and long 149° 58′ E , 250 miles from the mainland of Australia. The island is only about 600 yards by 250 yards at low water, and is less than 30 feet above low-water mark. It might thus be expected that the diurnal range should be one or two degrees only as over the ocean, instead of which the thermographs show frequently ranges of so much as 8° F The thermograph is fitted in a Stevenson screen, which is fixed on a base of concrete Dr. Kidson throws doubt on the efficiency of the Stevenson screen, but it is certain that the effect of the base of concrete must be very considerable. The cooling effect of showers of rain would appear to confirm this. In view of the ideal location of the island, it is highly desirable that observations should be taken there by means of properly ventilated instruments.

SOUND AND WIRELESS IN HYDROGRAPHY.—As a result of the extensive series of measurements of the speed of sound in sea water undertaken by the United States Coast and Geodetic Survey, the steamer *Guide* has been equipped with a special sound and wireless method of determining its position at sea during a hydrographical survey it is making of the coast of California. The equipment is described by Commander N. H Heck and Messrs. E. A. Eckhardt and M. Keiser, of the Bureau of Standards, in Special Publication No 107 of the Survey. A bomb of T.N T. is fired under-water by the ship and the sound wave is picked up by three shore stations provided with hydrophones. Each hydrophone by means of a relay sends out a wireless signal which is received by the ship. The interval between the firing of the

bomb and the reception of the wireless signal is recorded automatically on a chronograph, and from the records for the three stations the position of the ship is determined. Full particulars of the apparatus are given in the paper, and it has been found to give results as accurate as visual methods, and to be applicable during fog and rough weather when these methods are no longer of use.

ATOMIC COMBINATION AND THE QUANTUM THEORY.—Messrs. M Born and J. Franck, in the *Zeitschrift für Physik* of February 19, show that according to the quantum theory a stable molecule cannot be formed by the simple collision of two atoms, but that a triple collision is necessary, the third particle serving to carry off the excess of energy. In spite of this it is shown that molecules which are not fully quantified (quasi-molecules) may be formed, and that they may exist long enough to emit or absorb characteristic radiations which can be recognised in the spectrum of a gas When two atoms collide they move round their common centre of gravity in cometary orbits, and during a certain period their trajectories are not very different from those of the atoms of a stable molecule During this period it is possible for the quasi-molecule to be excited, an electron jumping into a higher quantum orbit, if this then falls back into the lower orbit, the quasi-molecule will emit a characteristic radiation In a similar manner characteristic absorption phenomena will be produced, absorption bands being formed without any structure due to rotational quantification and others where the signs of vibrational quantification (band groups) are weak. A number of spectra can be explained in this way, particularly certain appearances in the spectra of metallic vapours.

EÖTVÖS TORSION BALANCE.—An improved model of the Eötvös torsion balance has recently been put on the market by Messrs L Oertling, Ltd Hitherto visual observations in this type of instrument have necessitated the provision of long brackets to carry the observing telescopes, so that a large and heavy tent has been necessary for the protection of the balance In the new Oertling model, telescope arms are completely eliminated so that the effective width of the instrument is reduced considerably. This balance can be used either for visual reading or photographic self-recording, the change from one system to the other being possible by simply replacing a ground glass screen by a photographic dark slide. The rotation of the upper part of the instrument into various azimuth positions is effected by a clockwork mechanism controlled by an electric time clock, which also controls the illumination of the scales at the proper intervals, and moves the photographic plate. A special optical system enables a magnified image of the actual scale to be observed or photographed, while the sensitivity is also increased and is variable at will. The spaces between the three metallic walls of the balance are packed with special insulating materials, while additional protection is provided by a three-walled cylindrical tent, the inter-wall spaces of which are also packed. Arrangements are provided by means of which it is possible to read the instrument from outside the tent, through specially placed windows, so that it is unnecessary to open the tent door after the instrument has once been set up In this way it is claimed that temperature and radiation effects are reduced to an absolute minimum consistent with economical transport, while it is confidently anticipated that readings can be taken both by day and by night, and at least three stations occupied every twenty-four hours. Other modifications are introduced, among which may be mentioned the clamping of the balance to the tent after observations have been completed, enabling the instrument and tent to be moved together as a whole to the next station, after which the instrument is unclamped and relevelled, when it is immediately ready for use again.

THE LIMITING POSSIBILITIES IN STEAM PLANTS.—An examination of the available evidence and the fundamental facts in searching for the real upper limits to the sequence of operations in steam plants provided the subject matter for an interesting paper read by Profs A L. Mellanby and William Kerr before the North-east Coast Institution of Engineers and Shipbuilders on February 27. The paper opens with a discussion of the temperature limits, obviously a question of the properties of the materials employed The results of direct stress and fluctuating stress researches, together with creep-limit considerations, demonstrate an upper limit of 750° F to 800° F for the ordinary steels and the best non-ferrous metals With special steels, and allowing the possibility of fair advance to the metallurgist, the authors consider that 900° F represents the steam-plant limit The consideration of pressure limits is one of thermal efficiencies, and a critical survey of the factors involved indicates 1250 lb per square inch as the limiting pressure above which no gain need be expected, although it appears that there is too little prospective gain to justify actual advance beyond 1000 lb per sq. inch Discussing reheating, the authors consider that two stages of reheating requiring a total heat supply of between 40 and 50 per cent of the Rankine heat drop provide the true limit to the reheating process This condition is closely met by reheating pressures of 500 and 180 lb per sq inch The best feed-heating limits are obtained by choosing eight heaters operating on the range up to the saturation temperature corresponding to 1000 lb per sq inch The limiting cycle thus starts from initial conditions of 900° F. and 1250 lb per sq inch, involves re-superheating at intermediate pressures of 500 and 180 lb per sq inch, and includes the employment of about eight extraction feed heaters, equally stepped, on a range of liquid heats up to that corresponding to 1000 lb per sq inch pressure

SULPHIDE FOG PRODUCED BY BACTERIA.—The Eastman Kodak Company of Rochester, N Y, found that 65 gallons of metol-hydroquinone developer, used in a tank for developing motion picture negative film, suddenly began to give excessive fog Similar cases were observed when developer in a deep tank after a certain amount of use was at rest, unused, for at least two or three days, or when a smaller quantity was kept in a closed bottle Messrs M. L Dundon and J. I. Crabtree (*British Journal of Photography*, p. 172) investigated the trouble, and found sulphides in such developers either in solution or in the sediment. It has been shown that some bacteria are able to reduce thiosulphates, sulphites, and even sulphates to sulphides, and the authors confirmed the action with ordinary yeast. Bacteria were found in the faulty developers, "bacilli predominating although cocci were present." Such developers may be restored to good condition by adding about 0·5 gm. of lead acetate per litre to precipitate the sulphide. When a developer is used continuously, the dissolved silver salt precipitates the sulphide as it is formed, and the authors found that silver bromide was sufficiently soluble in the developer for this purpose. No substance has yet been found that can be recommended as a preservative against bacterial growth in a developer.

The Fifth Washington Meeting of the American Association for the Advancement of Science.

THE fifth Washington meeting of the American Association for the Advancement of Science was held during convocation week, December 29, 1924–January 3, 1925. This meeting was one of the larger, quadrennial meetings, which are regularly held in Washington, New York, and Chicago, and it surpassed all earlier meetings of the Association in the number registered as in attendance The registration figures for the last five meetings are as follows. Chicago (1921) 2413, Toronto (1921) 1832; Boston (1922) 2339, Cincinnati (1924) 2211, Washington (1925) 4206

The fifteen sections of the Association were well represented, and 36 associated societies, of which 24 are affiliated, met with the sections of the Association Eleven other scientific organisations met with the Association by invitation Altogether 252 scientific sessions were held, as well as a large number of business sessions, dinners, etc The total number of papers and addresses at Washington was about 1710

Washington has more scientific workers in proportion to its population than any other city of the country It has numerous institutions and organisations devoted to scientific research and to the spread of scientific knowledge The George Washington University, the National Geographic Society, the many government scientific bureaux and offices, the Smithsonian Institution, the Carnegie Institution of Washington, the National Academy of Sciences, and the National Research Council are all of Washington, and all took active part in the arrangements for this meeting The quarters of many of these organisations were made available for section and society sessions, and the Central High School building was secured for a large group of the sessions

The exhibition for this meeting was exceptionally well developed, and offered many unusual opportunities for the actual inspection of apparatus, materials, and facilities for research and teaching, as well as newly developed scientific methods and recent publications The general exhibition was the most complete and representative exhibition held by the Association in recent years Fifty business firms that supply scientific instruments and materials, and publishers of scientific books, took part, and a large number of individual men of science exhibited new research methods and instruments Special exhibitions by Washington scientific organisations formed an attractive feature this year The annual exhibition of recent scientific work of the Carnegie Institution of Washington was specially maintained for this meeting. The new building of the National Academy of Sciences and the National Research Council, which is accounted the finest of its kind in the world, was open for inspection daily; a very attractive and inspiring permanent exhibition of scientific principles and methods was displayed in this new "Temple of American Science." Many of the offices and laboratories of the United States Department of Agriculture were open to visiting scientific workers The U S Bureau of Standards, the New National Museum, the Old National Museum, the Smithsonian Institution building, and the Freer Art Gallery were also open for inspection. Exhibitions by scientific societies that took part in the meeting were arranged, these were generally of special interest to workers in the fields represented by the societies, and contained exhibits of research methods and apparatus shown by their originators

With a rapidly increasing public interest in scientific knowledge, the recent annual meetings of the American Association have received a progressively greater share of attention on the part of the daily press. One of the chief aims of the Association is to further the appreciation of science and the work of scientific men, and it has rapidly improved its publicity service in recent years This service now constitutes a very important feature of each annual meeting. It aims at furnishing to the newspapers throughout the country interesting and trustworthy items from the various scientific programmes. The Publicity Committee was very efficiently helped by the co-operation of Science Service, which furnishes science news to a series of subscribing newspapers. For the first time in the history of the American Association, radio was used as an integral part of the publicity service. The two large stations in Washington broadcasted talks given by well-known scientific men whose influence on the upbuilding of science is generally recognised. The territory covered by the two stations is very wide, responses from their programmes having been received from Hudson Bay, Seattle, San Francisco, Long Beach, Los Angeles, Honduras, San Salvador, Cuba, and Haiti Through radio talks, a vast number of people were reached who are deeply interested in the acquisition of scientific knowledge but unfamiliar with the channels through which accurate information may be obtained The great value of thus broadening the contacts of the annual meetings of the Association and of stimulating a wider interest in and appreciation for scientific work can scarcely be overestimated.

Eight general sessions of the Association were held at Washington The opening session occurred on Monday evening, December 29, in the Memorial Continental Hall This session was addressed by the Honourable Charles Evans Hughes, Secretary of State, who spoke on "Some Aspects of International Co-operation" At this session was delivered the address of the retiring president of the Association, Dr Charles D Walcott, secretary of the Smithsonian Institution The subject of Dr Walcott's address was "Science and Service" Following the opening session, there was a general reception given by the local Association members. The reception was held in the New National Museum

The second general session was held on Tuesday afternoon, December 30 The speaker at this session was Mr Austin H Clark, of the Smithsonian Institution, member of the Navy Department's Advisory Committee on Oceanography Mr. Clark's subject was "The Navy's Oceanographic Program."

The third general session was held on Tuesday evening, December 30 This session was devoted to the third annual Sigma Xi lecture, held under the joint auspices of the Association and the Society of Sigma Xi The lecture this year was by Dr. Frederick Fuller Russell, general director of the International Health Board, whose subject was "War on Diseases, with Special Reference to Malaria and Yellow Fever."

The fourth general session occurred on Wednesday afternoon, December 31. At this general session Dr. Charles D Walcott gave a beautifully illustrated lecture of general interest on "Geological Exploration in the Canadian Rockies"

The fifth general session was held on Wednesday evening, December 31. A fine series of motion pictures, taken on the western excursion that succeeded the recent Toronto meeting of the British Association, was shown at this session Dr. Edwin E. Slosson, director of Science Service, who took part in the trip, spoke These films were very kindly loaned for this showing by the Provincial Motion Picture Bureau

of Ontario, Canada. Many striking and beautiful Canadian views were seen, and a number of eminent British scientific workers appeared in the pictures

The sixth general session was held on Thursday afternoon, January 1 Prof. A. E Douglass, director of the Observatory of the University of Arizona, spoke on the "University of Arizona Eclipse Expedition of September 1923," and showed beautifully coloured lantern slides Besides its contribution of astronomical knowledge presented in an easily understood style, this lecture also presented something of desert adventure that did not fail to attract attention

The seventh general session occurred on Thursday evening, January 1. Dr. Willis T. Lee, of the United States Geological Survey, gave a lecture at this session, on "Explorations in the Carlsbad Caverns of New Mexico" The studies reported were carried out under the auspices of the National Geographic Society Dr Lee's illustrations included motion pictures secured by means of flares in these very interesting caves

The eighth general session was held on Friday afternoon, January 2. Motion picture films illustrating the principles and operation of the telephone, human speech, etc , were given their first public showing, and an explanatory talk was given by Dr John Mills, of the Western Electric Company of New York City

The following is a list of the vice-presidential (sectional) addresses delivered at Washington ; they are being published in full in *Science* —Section A (*Mathematics*)—" The Foundations of the Theory of Algebraic Numbers " By Harris Hancock, University of Cincinnati Section B (*Physics*)—" Trend of Thought in Physics " By W F G. Swann, Yale University. Section C (*Chemistry*)—" Some Effects of the Atmosphere upon Physical Measurements " By E W Washburn, National Research Council, Washington, D C Section D (*Astronomy*)—" The Equinox of 1950 " By Heber D Curtis, Allegheny Observatory, Pittsburg, Pa. Section E (*Geology and Geography*)—" A Classification of Natural Resources " By N M Fenneman, University of Cincinnati Section F (*Zoological Sciences*)—" Darwin and Bryan: a Study in Method " By Edward L Rice, Ohio Wesleyan University, Delaware, Ohio. Section G (*Botanical Sciences*)—" The Origin of the Cycads " By C J. Chamberlain, University of Chicago Section K (*Social and Economic Sciences*)—" The Development of Modern Family Life " By John Franklin Crowell Section L (*Historical and Philological Sciences*) —" Leibnitz, The Master Builder of Mathematical Notations " By Florian Cajori, University of California. Section N (*Medical Sciences*)—" The Relation of Certain Free Living Micro-Organisms to Disease." By Richard P Strong, Harvard University Section O (*Agriculture*)—" Better Adapting our Educational and Investigational Efforts to the Agricultural Situation." By R. A Pearson, Iowa State College Section Q (*Education*)—" The New Social Order as seen from the Standpoint of Education " By Henry W. Holmes, Harvard University.

The Council of the Association met on various occasions during the meeting for the transaction of business, some items of which are of general interest.

Under the provisions of the Jane M. Smith Fund, the following three members were elected to emeritus life membership of the Association : Ira Remsen, Johns Hopkins University, E. S. Dana, 24 Hillhouse Ave., New Haven, Conn.; H C. Yarrow, 814–17th St., N.W., Washington, D.C.

The sum of 3000 dollars was appropriated for grants for research in 1925, to be allotted by the Committee on Grants and disbursed from the available funds of the treasurer's office The Council appropriated 500 dollars as a temporary aid to the Union of American Biological Societies in its project for *Biological Abstracts* It was decided that the annual meeting of December 1927 shall be held in Nashville, Tennessee.

Prof Michael Pupin, professor of physics in Columbia University, New York, was elected president of the Association The following vice-presidents (chairmen of sections) and secretaries of sections were also elected :—*Section A* . W. A. Roever, professor of mathematics, Washington University, St Louis ; R. C. Archibald, associate professor of mathematics, Brown University, Providence, R I *Section B* : H M. Randall, professor of physics, University of Michigan ; A L. Hughes, Washington University, St Louis, Mo *Section C* H. B Cady, professor of chemistry, University of Kansas ; Gerald Dietrichson, University of Illinois, Urbana, Illinois *Section D* A. E Douglass, professor of astronomy, University of Arizona ; Philip Fox, professor of astronomy, Northwestern University, Evanston, Ill *Section E* : R A Daly, professor of geology, Harvard University , G R Mansfield, U S Geological Survey, Washington, D C *Section F* . H S. Jennings, professor of zoology, Johns Hopkins University , G T Hargitt, professor of zoology, Syracuse University, Syracuse, N Y *Section G* R B Wylie, professor of botany, Iowa State University , S F Trelease, professor of plant physiology, University of Louisville, Louisville, Ky *Section H* C B Davenport, director of the Station for Experimental Evolution, Carnegie Institution of Washington ; R J Terry, professor of anatomy, Washington School of Medicine, St Louis, Mo *Section I* C. E Seashore, professor of psychology, Iowa State University , F N Freeman, professor of physiology, University of Chicago, Chicago, Ill *Section K* F R. Fairchild, professor of political economy, University , F L Hoffman, Babson Institute, Babson Park, Mass *Section L* W A. Oldfather, professor of classics, University of Illinois , F E. Brason, Congressional Library, Smithsonian Division, Washington, D C *Section M* F G Cottrell, director of the Fixed Nitrogen Laboratory, U S Department of Agriculture , N H Heck, U S Coast and Geodetic Survey, Department of Commerce, Washington, D C *Section N* A J Carlson, professor of physiology, University of Chicago , A J Goldfarb, professor of biology, College of the City of New York, New York, N Y *Section O* C V Piper, agrostologist, U S Department of Agriculture , P. E Brown, Iowa State College, Ames, Iowa *Section Q* O W Caldwell, director of the Lincoln School, Columbia University ; A S Barr, University of Wisconsin, Madison, Wis.

Other officers are : *Permanent Secretary* Burton E. Livingston, director of the Laboratory of Plant Physiology, Johns Hopkins University, Baltimore, Maryland. *General Secretary* : W. J Humphreys, professor of meteorology, George Washington University and U S. Weather Bureau, Washington, D.C. *Treasurer* : J L Wirt, Carnegie Institution of Washington, Washington, D.C. *Elected Members of Council* . Dr L O. Howard, Chief of the Bureau of Entomology, U S Department of Agriculture, Washington, D C. ; Dr D T. MacDougal, director of the Desert Laboratory, Carnegie Institution of Washington, Tucson, Arizona. *Elected Members of the Executive Committee* : B M. Duggar (1925), Missouri Botanical Garden, St Louis, Mo , Edwin B Wilson (1928), Massachusetts Institute of Technology, Cambridge, Mass. ; Vernon L Kellogg (1928), permanent secretary of the National Research Council, Washington, D.C.

Innermost Asia: its Geography as a Factor in History.

ON Tuesday, March 24, at a meeting of the Royal Anthropological Institute, Sir Aurel Stein read a paper on "Innermost Asia: its Geography as a Factor in History." It dealt with the part which the elevated drainageless basins between Tibet in the south and the great Tian Shan range in the north have played for two thousand years as a natural corridor for the interchange of the civilisations of China, India, and the West. This vast region, stretching for close on 1600 miles from east to west, is for the most part occupied by deserts of drifting sands, wind-eroded steppe, and bare gravel By denying to this region adequate atmospheric moisture and grazing grounds, Nature has protected it from becoming the scene of great nomadic migrations and of the upheavals entailed by them. Cultivation all through historical times has there been entirely dependent on irrigation, and hence restricted to a thin string of oases along the foot of the encircling mountains

The safe trade route passing through these oases was first opened when the Chinese in the last quarter of the second century B C forced the Huns to the north of the Tian Shan, and then pioneered a track into the Tarim basin through the Lop Desert China's policy of Central-Asian expansion at first aimed at securing an open road westwards for its exports, and particularly for its silk fabrics, the most valuable of its industrial products, of which it long retained a monopoly The necessity of safeguarding this road forced the Chinese empire into gradually extending political and then military control right across the Pamirs and even beyond

Sir Aurel Stein, on the second and third Central-Asian expeditions undertaken under the orders of the Indian Government, traced this ancient Chinese route along its whole length. By systematically exploring the ruins of the watch stations once guarding the ancient Chinese border wall west of Tun-huang, and of ancient settlements in the Tarim basin, abandoned from the third century A.D onwards, to the desert, on ground now wholly waterless, he brought to light abundance of interesting relics of the traffic and trade once passing along this road. Among the most noteworthy of these relics are remains of beautiful Chinese figured silks of the first centuries before and after Christ, and also of fine tapestries of unmistakably Hellenistic style. Hundreds of documents on wood in Indian script and language of the third century A D attest how the same route in the reverse direction served for that spread of Buddhist doctrine to the Far East which forms the most important of India's many notable contributions to the spiritual development of civilised mankind Fine paintings on silk and stucco sculptures in plenty show how Græco-Buddhist art from the north-western marches of India simultaneously penetrated into China and influenced its native art

The opening of the earliest route through the Lop Desert comprising the salt-encrusted dry bed of a prehistoric sea affords striking evidence of that remarkable power of intelligent organisation which enabled the Chinese through successive periods to overcome formidable natural obstacles The same capacity, far more than force of arms, helped them to regain control of those distant regions more than once during successive ages after it had been lost through internal decay of imperial authority.

Plentiful archæological finds, as illustrated by Sir Aurel Stein's slides, showed how the cultural influences of India, China, and the Near East intermingled in the Tarim basin during close on a thousand years. The remarkable preservation of these remains proves the extreme aridity of the climate prevailing here since ancient times. The same atmospheric dryness has made it possible in the Lop Desert for bodies of inhabitants of ancient Lou-lan to survive in a remarkable state of preservation since the first centuries of our era. They suggest that the people in the Tarim basin, whom we know spoke various Indo-European languages, showed in their physique the same *Homo alpinus* type which Mr. Joyce's analysis of the anthropometrical material collected by Sir Aurel Stein proves to be the prevailing element in the racial constitution of the present population of the oases

University and Educational Intelligence.

OXFORD.—A special course in zoology for teachers of science in secondary schools has been arranged for in the department of zoology and comparative anatomy from July 31 to August 11 Forms of application and all particulars can be obtained from the Rev F. E Hutchinson, Acland House, Broad Street, Oxford.

APPLICATIONS are invited by the trustees of the Manchester Royal Infirmary for the Dickinson Surgery Scholarship, value 75*l* for one year The scholarship is open to students who have received at the university and the infirmary, instruction in pathology, medicine, and surgery necessary for the taking of the M B, Ch B (Manchester) degree The latest date for the receipt of applications (in each case six in number) by the Secretary is April 30

AN Educational Policy for Tropical Africa is outlined in a memorandum prepared by the committee appointed in November 1923 to advise the Secretary of State for the Colonies on such matters, and published as command paper 2374 of March 1925. Mr Ormsby-Gore, Parliamentary Under-Secretary of State for the Colonies, is the chairman of the committee, which includes also the Bishop of Liverpool, Sir Frederick Lugard, Sir Michael Sadler, Major A. G. Church, and Mr. J H Oldham Native education, which, until recently, has been largely left to the Mission Societies, will, if the committee's views are adopted, become the field of a great government missionary enterprise, the keynote of which would be adaptation to native life. The point of view is conservative in the best sense. The salvaging of the best of barbarism is recognised as a necessary condition of the growth of anything worth calling civilisation A dual system is to be maintained, and, in provided and non-provided schools alike, as well as in training colleges, religious teaching and moral instruction are to be accorded an equal standing with secular subjects Examinations are not to be given the position of cardinal importance they have usurped so often, for the conditions under which grants-in-aid are given are not to be dependent on examination results Supervision is to be exercised through an adequate staff of government inspectors, whose reports are to be based on frequent and unhurried visits, a primary purpose of which will be to make the educational aims understood and to give friendly advice and help in carrying them out. Departmentalism, which has so greatly vitiated the working of government educational administration in the past, is to be kept in check by close co-operation, as in the United States, with every department of government concerned with the welfare of the people or vocational teaching, including especially the departments of Health, Public Works, Railways, and Agriculture. To be instrumental in carrying out such a policy is an ambition that should fire the enthusiasm of university men not less than did the Indian Civil Service in its palmiest days.

Early Science at Oxford.

April 20, 1686. Dr. Plot read an account of makeing brasse, as it is practised in Holland

April 22, 1684. Dr Smith communicated some abstracts of letters, he lately received from beyond Sea

From Paris Monsieur Auzout affirms, that no great Loadstone, tho capped, will take up above 12, or 15, times its weight, but, he says, that in Italy he has seen little Loadstones, which have rais'd 80 times their weight, and some 140 times their weight

In a certain province of Nova Francia, there is so great a quantity of salt peter in ye feilds, that ye oxen there are so salt that they cannot eat their flesh, for 3 or 4 months in ye year, ye steams of salt peter falling in that abundance upon ye grass

Sheep in Affrick, that have teeth with *aurea armatura*

Bees in ye West Indies which have no sting, which place ye young ones in their honey; and their fæces in seperate cells their honey is as clear as water

From Liège On ye 4th of February S N severall Colliers were imprisoned in a Colepit at Herstol, half a league from Liège through a vein of water gushing in very violently upon them Twenty four days were spent in drawing off ye water, and upon ye 25th, they were taken up all alive, not haveing had one morsell of bread during all that space, and subsisting onely upon a spring that flowed near them a great quantity of this water was evaporated, to try, if they could discover any thing of nourishment in it, more than in common water, but they found nothing but a scarce perceptible calx remaining

From Paris A New Mathematicall Instrument lately invented at Paris, made very comodious for travelling, and so light, that it may be carried in one's pocket; it serves for a semicircle, sector, square, measuring all sorts of angles whatsoever, takeing ye weight of bullets, ye declination from ye North, ye inclination, or reclination, of any wall, or whatever it be, and many other uses it hath, which seem to be demonstrable.

Dr Plott brought in an account of ye effects of ye late hard frost on ye vegetable kingdom, drawn up by Mr. Bobart, Gardiner to ye University Capt Ralph Sneyd of Bradwell in Staffordshire, sais that a great oak at Chebsey in that County, vallued at 12d ye last Autumn, was splitt quite thro by ye frost this Winter Dr Plot also informed ye Society, that both resinous and gummy, trees have suffered very much by ye last Frost, but ye latter much more than ye former likewise he shewed ye Society a lamp, whose wick was made of Salamander's wool, in order to a Discourse of sepulchrall lamps now under his hands. A letter was lately received from Mr King of Ingestre, in Staffordshire, concerning an æquinoctiall Diall in that Country, representing a booke opened, ye edges of ye booke were Gnomons, casting a shade on ye opposite side, where ye hours were exprest by parallel lines.

April 23, 1686. Being St George his Day, ye day of Election, Dr. Wallis was chosen President, Dr Plott Director of Experiments, Mr Caswell Treasurer, Mr. Bainbrig and Mr Walker Secretaries —Ordered that ye payments be sunk down to 2*s* 6*d* a quarter, for ye year ensueing.

1690. Ordered by the Society, that all members of the Society who have paid their arrears on Lady Day, 1688, are to receive six books of Aristarchus, printed at the charge of the Society

Officers for the ensuing yeare: Dr. Bathurst President, Mr. Pit and Mr. Hans Secretaries, Dr Musgrave, Director of Experiments, Mr Pullen, Treasurer.

Societies and Academies.

LONDON

Physical Society, March 13 —Jas P **Andrews** The variation of Young's modulus at high temperatures The variation is found for zinc, silver, phosphor-bronze, lead, and soda glass by a static method, to within about 150° of the melting-point It varies exponentially with temperature, so that q (Young's Modulus) $= q_1 e^{-b_1 t}$ (where q_1 and b_1 are constants) up to a temperature roughly half-way from absolute zero to the melting-point, and $q = q_2 e^{-b_2 t}$ for the remainder —E G **Richardson** The critical velocity of flow past objects of aerofoil section By observations of the "Æolian tones" of vibrators of aerofoil section, critical values for flow past an object of aerofoil section have been obtained of a fluid incident at various angles The minimum value of VL/ν for unsteady flow falls from 60 at 0 incidence to 45 at 20, and then more rapidly —J **Brentano** A focussing method of crystal powder analysis by X-rays For any given angle of reflection, a surface of double curvature can be found, such that it will reflect X-rays coming from one point, to any other definite point For an element of this surface, situated so as to be distant from the two points by lengths a and b respectively, the relation $\sin\alpha/\sin\beta = a/b$ must be satisfied, where α and β are the glancing angles of incidence and of emergence of the X-rays with respect to the surface An arrangement for crystal analysis based on this relation is discussed

DUBLIN

Royal Irish Academy, March 16 —J J **Nolan**, R K. **Boylan**, and G P **de Lachy** The equilibrium of ionisation in the atmosphere The large ions in the atmosphere carry single electronic charges They constitute a constant fraction of the nuclei of the atmosphere, and the ratio of the uncharged nuclei to the large ions of one sign is approximately 1·28 The equilibrium between small ions (n) and large ions (N) is determined by the equation $q - \alpha n^2 + 2\eta_2 N n$, η_2 being the recombination coefficient between small ions and large ions of the opposite sign Where large ions are plentiful, $q = 2\eta_2 N n$ The value of η_2 is $9\ 7 \times 10^{-6}$ The large ions exert a marked effect on the atmospheric potential gradient

PARIS

Academy of Sciences, March 2 —G **Koenigs** The differential equations of movements with two doubly decomposable parameters —Maurice **Hamy** The photography of the stars in full daylight A modified Lindemann method is described which permits of the determination of the magnitude of the stars photographed —Roland Thaxter was elected corresponding member for the section of botany in succession to the late M De Toni —R. H **Germay** A method of integrating by successive approximations of systems of partial differential equations of fixed form — **Mandelbroit** The analytical prolongation of monogen functions in the sense of Cauchy into isogen functions in the sense of Volterra —René **Lagrange** The quadratic integrals of the equations of mechanics — **St. Kempisty** Approximative (asymptotic) limits —Harald **Bohr** Nearly periodic functions with one complex variable — — **Salet** The independence of the velocity of light and of that of the source of light. —E **Delcambre**, Ph **Wehrlé**, and L **Gouton** The variability of true astronomical refractions A description of an experiment from which it is concluded that on a single angular measurement of isolated stars, the approximation to 0·01″ is illusory,

even for small zenithal distances, and this is also the case for the approximation to o 1″ for zenith distances higher than 45°.—E. Henriot and R. Moens: The action of light on the thermionic phenomenon. The light of an arc lamp, interrupted 1000 times per second by a toothed wheel, is focussed on an incandescent tungsten filament. Under these conditions, a telephone interposed in series with the high-tension battery in the filament-plate circuit gives the sound corresponding to the 1000 frequency. If the current through the filament is too small, the sound is not heard, and it is only apparent within a narrow range of current. The phenomenon appears to be purely thermal, and is not really photo-electric.—C. G. Bedreag: Physical system of the elements.—A. Boutaric and Mlle. F. Demora: The phenomena of diffraction presented by a network composed of alternative transparent and opaque sectors.—F. Holweck: Exact measurements of spectral frequencies in the domain of the radiations comprised between light and the X-rays (the L III discontinuities of Cl, S, P, Si, Al).—J. Salauze: The electrolysis of the alkaline acetates in solution in methyl alcohol. Comparing the effects in the two solvents, water and methyl alcohol, in the latter, oxidation phenomena are absent, and the yield of ethane is higher (95 per cent against 85 per cent.) The nature of the anode has a much smaller influence on the course of the reaction in methyl alcohol than in aqueous solution.—Paul Pascal: The magneto-chemistry of polymers. Measurements of the magnetic susceptibility of the metaphosphates. Conclusions can be drawn from the data concerning the complexity of the various forms of metaphosphate.—A. Bigot: Clays, kaolins, light silicas: density, porosity, occluded gases.—B. Cabrera: The rare earths and the magneton question.—H. Wuyts: General method for the preparation of the ether oxides. To the alcohol 10 per cent of sulphuric acid is added, and the mixture slowly distilled through an efficient fractionating column. The alkyl oxide, alcohol, and water distil as azeotropic mixtures, from which the alkyl oxide (ether) can be separated.—Louis Jacques Simon: The relations between sulphochromic oxidation and structure.——Lespieau and Charles Prévost: Diacetylene. By the action of excess of alcoholic potash on erythrene tetrabromide, a gas was obtained which liquefies at − 35° C. and boils at about 10° C. It was not analysed, but its physical properties and chemical reactions correspond with those of diacetylene CH C − C CH.—R. Fric: The presence of methane in various outflows of gas observed in the Limogne d'Auvergne. The gas from a trial boring was collected and analysed, and found to contain carbon dioxide, sulphuretted hydrogen, oxygen, nitrogen, and methane (19 8 per cent.).—Alphonse Berget: A marine refractometer with double deviation. This instrument consists of two hollow prisms, one inside the other. The outer one is filled with a liquid of known refractive index, the liquid of which the refractive index is required being placed in the inner prism. Both liquids are necessarily at the same temperature, and the accuracy of the differential measurement is one in the fifth place of decimals.—A. Gruvel: Remarks on the salinity curve of the waters on the western coast of Morocco.—P. Bugnon: Leaf homologies in the sweet violet, vegetative leaves, pre-leaves and bracts.—Henri Coupin: The peroxydases in dry seeds. The benzidine-hydrogen peroxide reagent serves well to detect peroxydases in dry seeds.—Mlle. G. Bonne: The presence of internal phloem in some Rosaceae.——Lisbonne: The activation of the pancreatic juice by acidification.—Jean Saidman: The photo-electric effect produced by ultra-violet light in man. Normally a man exposed to ordinary daylight loses negative electricity, and the rate of loss is unchanged by exposure to a 2000-candle half watt lamp. But submitted to ultra-violet light (quartz mercury lamp), a rapid discharge is produced.—A. Dognon: The biological action of monochromatic X-rays of different wavelengths on the egg of Ascaris.—Pierre P. Grasse: Cysts of Prowazekella and Blastocystis.—A. Henry and Ch. Leblois: Attempt at the classification of the Isospora.—H. Penau and H. Simonnet: Prolonged insulin treatment and survival of the dog without pancreas.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 1, January 1925).—W. Lindgren: (1) The cordierite-anthophyllite mineralisation at Blue Hill, Maine, and its relation to similar occurrences. The Ellsworth schists here contain mainly quartz, biotite, and chlorite, and the ores form lenticular replacements in them. The type of mineralisation described is recorded for the first time in America, and appears to be due to emanations from the granite outcrop nearby. The deposit is similar to those of Fenno-Scandia. (2) Gel replacement, a new aspect of metasomatism. Gel replacement in solid rocks operates in general at medium to low temperatures, probably not above 300° C. Solutions or sols attack the matrix and the space is filled by a gel of high concentration. If crystallisation takes place slowly, concentric fibrous texture results, if it is almost simultaneous with deposition, there may be apparent continuity. The theory is applied to replacements by silica gel, sulphides, and to the veins of Cobalt, Ontario.—J. W. Gowen, H. W. Leavitt, and W. S. Evans. Mortar strength, a problem of practical statistics. The correlation coefficients for tests after 7-day and 28-day curing respectively are high, so the behaviour of mortar can be safely predicted on the data from 7-day tests.—Raymond Pearl and L. J. Reed. Skew-growth curves.—J. H. Mueller: Chemical studies on tuberculin. The active principle of tuberculin may be a protein or a protein degradation product, on the other hand, the specific precipitable material of tuberculin is resistant to the action of proteolytic enzymes.—S. K. Allison and W. Duane: On scattered radiation due to X-rays from molybdenum and tungsten targets. X-ray tubes of small diameter and a multiple slit system were used. With a narrow beam of primary rays the ionisation curves show a narrow peak beside the unshifted peak, and with a wide beam, a broad shelf, both of which were in agreement in position, for several radiators, with Compton's theory.—C. M. Blackburn. An application of the quantum theory of band spectra to the first negative Deslandres group of carbon. The bands lie in the ultra-violet between 2100 and 2900 Å.U. The emitter seems to be a dipole molecule in simple rotation about a non-precessing axis perpendicular to the line joining the nuclei.—W. W. Coblentz and C. O. Lampland: New measurements of planetary radiation and planetary temperatures. By means of a series of transmission screens, the radiations were separated into spectral groups and the radiation intensity of each determined by new radiometers. The unilluminated part of the disc of Venus emits much infra-red radiation, suggesting a short rotation period (1-10 days). Illuminated regions of Mars seem to be at 5-15° C., polar regions, perhaps − 70° C.; dark phase on sunrise side, perhaps − 60° C. Surface temperature of Jupiter and Saturn appears to be − 60° or − 80° C.—E. H. Hall: The number of free

electrons with a metal. The relation between the atoms, free electrons, and ions within a metal are essentially those of dissociation equilibrium. The free electrons may be 2-3 per cent of the number of atoms and increase with temperature. This gives an ionising potential of the solid metal of ½ volt for cobalt to ¼ volt for iron at 0° C.—F. G. **Keyes** and F. W. **Sears**. Recent measurements of the Joule effect for CO_2. A glass bomb containing the gas is broken in a vacuum and the temperature change measured by a platinum resistance wire.—H. B. **Lemon**. The comet tail spectrum and Deslandres' first negative group. Helium pumped through activated carbon gives a brilliant comet tail spectrum. The spectrum is also given by a hydrogen tube containing carbon cooled to liquid air temperature and with a hot cathode, but is feeble.—W. F. **Meggers**. The periodic structural regularities in spectra as related to the periodic law of the chemical elements. The spark spectrum (from ionised atoms) resembles in structure the arc spectrum (from neutral atoms) of the preceding element (Displacement Law). Even and odd structures, *i.e.* doublets and triplets, etc., characterise the arc spectra of alternate elements in columns I.-VIII. of the periodic classification, and even and odd structures their spark spectra (extension of Rydberg's Alternation Law). Experimental verification.—E. L. **Nichols**. Notes on neodymium oxide. The oxide in bulk or in a bead gives a band spectrum of two identical sets, though the bands are generally in different places. There are two absorption spectra: the reversal of the bead spectrum and the spectrum of an aqueous solution. The same two sets of bands appear together with a third.—A. H. **Pfund**. Halogen isotopes and infra-red reflection spectra. Potassium salts of the halogens have as many bands of selective reflection in the infra-red as there are isotopes. Plotting wave-numbers ($1/\lambda$) against atomic weights gives two parallel straight lines, the lighter isotopes, together with iodine, falling on one line.—P. A. **Ross** and D. L. **Webster**. (1) The Compton effect with no box around the tube. The apparatus was so arranged that radiation from any light element other than the secondary radiator had to travel a distance by which, according to the inverse square law, its intensity would be made negligible. Compton's predicted shift is confirmed, but no trace is found of the tertiary radiation suggested by Duane. (2) Compton effect: evidence on its relation to Duane's box effect. The intensity of scattered radiation from a box enclosing the X-ray tube and secondary radiator as calculated using Barkla's mass-scattering coefficient is inadequate to explain the peak observed by Duane in the box experiments.—H. **Boschma**. The nature of the association between Anthozoa and Zooxanthellæ. Coral polyps containing algæ are substantially parasitic on them, apparently owing to lack of organic food. Given organic food, they cease to ingest the algæ.—T. L. **Davis**. The mechanism of reactions in the urea series. The mechanism in many cases is the reversible combination of molecules: the urea derivatives de-arrange or break down in a predictable manner analogous to the de-arrangement of urea into ammonia and cyanic acid.—L. J. **Gillespie**. An equation for the Haber equilibrium.—G. **Glocker**. A critical potential of methane and its absorption in the ultra-violet. The maximum in the current-potential curve of three- and four-electrode methane tubes is not due to a resonance potential.—H. W. **Underwood, Jr.**: Studies in catalysis. Negative catalysts or "stabilisers" seem to act by the formation of loosely combined molecular compounds.—W. J. **Crozier** and H. **Federighi**: On the measurement of critical thermal increment for biological processes. The logarithm of frequency of heat-beat in the silk-worm bears a linear relation to the reciprocal of the absolute temperature, elaborate precautions are necessary to eliminate chance variations.—P. **Bailey** and Harvey **Cushing**. Micro-chemical colour reactions as an aid to the identification and classification of brain tumours.—S. **Flexner**. Virus encephalitis in the rabbit. The contents of febrile herpes vesicles and allied substances from man set up this inflammation of the brain in the rabbit. The virus appears to have at times a general distribution throughout the human body.—W. J. **Luyten**. Notes on stellar statistics. II. The mathematical expression of the law of tangential velocities.—G. C. **Evans**. Economics and the calculus of variations.—E. **Kasner**. Separable quadratic differential forms and Einstein solutions.—D. N. **Lehmer**. On a new method of factorisation. Legendre's method of factorisation, which makes use of the fact that all numbers having a given quadratic residue contain only such prime divisors as belong to certain linear forms, is to be utilised to construct stencils. The combination of any number of sets of these forms can then be accomplished by piling the corresponding stencils one on top of the other.—A. D. **Michal**. Functionals of curves admitting one-parameter groups of infinitesimal point transformations.—E. C. **Jeffrey**. (1) Resin canals in the evolution of the conifers. Contrary to current opinion in Europe, it is concluded, from the evidence of wound resin canals in fossil coniferous woods, that the Abietineæ (pines) represent the parent stock of the group. (2) The origin of parenchyma in geological time. Storage parenchyma has been derived from tracheids, it appeared first at the end of the annual ring, being related to the extra supplies required by the cambium in spring, and often shows every gradation towards tracheary elements.

Official Publications Received.

University of Illinois Engineering Experiment Station. Bulletin No. 147. Non-Carrier Radio Telephone Transmission. By Hugh A. Brown and Charles A. Keener. Pp. 26. (Urbana, Ill.) 15 cents.

Shirley Institute Memoirs. Vol. 3, 1924. Pp. vi+362+iv. (Manchester: British Cotton Industry Research Association, Didsbury.)

State of Illinois Department of Registration and Education. Division of the Natural History Survey. Bulletin, Vol. 15, Art. 4. A Preliminary Report on the Occurrence and Distribution of the Common Bacterial and Fungous Diseases of Crop Plants in Illinois. By L. R. Tehon. Pp. viii+173-325. (Urbana, Ill.)

Records of the Botanical Survey of India. Vol. 10, No. 2. The Botany of the Abor Expedition. By I. H. Burkill. Pp. 115-420+10 plates. (Calcutta: Government of India Central Publication Branch.) 5.3 rupees, 8*s.* 6*d.*

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 5, 1923. V. Hydrografiska mätningar i Sverige. Pp. 86+4 plates. (Stockholm.) 5 kr.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 1. Meteorologiska Resultat av en Sommarseglats runt de Britiska Öarna. (Meteorological Results of a Summer Cruise round the British Isles.) With an English Summary. Av Carl Gustaf Rossby. Pp. 16. (Stockholm.) 1 kr.

Abisko Naturwetenskapliga Station. Observations météorologiques à Abisko en 1917. (Meteorologiska Iakttagelser i Abisko år 1917.) Redigées par Bruno Rolf. Pp. 75. (Stockholm.)

Board of Education. Vacation Courses in England and Wales, 1925. Pp. 18. (London: H.M. Stationery Office.) 6*d.* net.

The Quarterly Journal of the Geological Society. Vol. 81, Part 1, No. 321, March 25th. Pp. xlviii+112+9 plates. (London: Longmans, Green and Co.) 7*s.* 6*d.*

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. 9, 1924. Pp. 700. (London: The Society of Chemical Industry.) 7*s.* 6*d.*, to non-members, 12*s.* 6*d.*

Diary of Societies.

SATURDAY, APRIL 18.

MINING INSTITUTE OF SCOTLAND (Annual Meeting) (at Royal Technical College, Glasgow), at 3.—Prof. H. Brigg: Sinclair's Treatise on Coal-mining, 1672 (Seventeenth Century Mining in East Lothian).—J. H. Cockburn: The Principles and Operation of the Mines (Working Facilities and Support) Act, 1923, Part 1.—C. N. Kemp and W. M'Laren: Demonstration on Coal Washing.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Municipal College of Technology, Manchester), at 7.—A. Hill: Foundry Materials.

MONDAY, APRIL 20.

ROYAL MICROSCOPICAL SOCIETY (Conference at the University, Sheffield), in morning.—J. E. Barnard: Modern Microscopical Methods.—Conrad Beck: Resolution and Illumination with the Microscope.—Dr. F. J. Brislee: Dark-Ground Illumination for the Examination of Textile Fibres.—Dr. W. E. Cooke: The Neutrophil Polymorphonuclear Leucocyte in Pernicious Anæmia.—Dr. C. Da Fano: The Golgi Internal Apparatus of Nerve Cells.—Sir Kenneth Weldon Goadby: Note on Lung Fibrosis in Iron Mining.—Sir Robert A. Hadfield, Bart., T. G. Elliot, and G. B. Willey: The Development and Use of Microscopic Methods of Investigation in Steel Works.—B. H. Hoole: The Life History of the Entomostraca.—F. F. Lucas: Some Recent Developments in Metallurgical Research: New Facts developed by High Power Metallography.—Dr. R. J. Ludford: The Cytology of Cancer.—Dr. J. A. Murray: Stained Preparations of Rotifers.—Capt. J. Ramsbottom: Some Points in the Histories of Yeasts.—A. Subba Rau and Dr. F. W. R. Brambell: Staining Methods for the Demonstration of the Golgi Apparatus in Fresh Vertebrate and Invertebrate Material.—F. I. G. Rawlins: Microscopy and the Modern Physics.—W. J. Rees: The Microscopical Examination of Refractory Materials.—Dr. F. Rogers: Test Objects for Metallurgical Microscopy.—J. F. Strachan: The Microscopical Structure of Paper-making Fibres in Relationship to their Manufacturing Properties.—H. Wrighton: Some Details in Metallurgical Microscopy.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr. M. G. Kyle: Genesis' Record and the Antiquity of Man.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Dr. V. Meinesz: The Determination of Gravity at Sea in a Submarine.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—G. W. Watson: Brakes for Motor Vehicles.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—M. Hart and others: Discussion on Latter-day Wireless.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—P. J. Waldram: Natural and Artificial Lighting.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. Jessie White: The Relation of Pedagogy to Philosophy.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. S. S. Brame: Motor Fuels (Howard Lectures) (I.).

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow).

INSTITUTE OF BREWING (London Section) (at Engineers' Club, Coventry Street, W.1).—H. W. Harman: Yeast Pressings.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court, S.W.).

TUESDAY, APRIL 21.

ROYAL MICROSCOPICAL SOCIETY (Conference at the University, Sheffield), in morning. (For Papers see April 20.)

ROYAL ANTHROPOLOGICAL INSTITUTE (jointly with the Prehistoric Society of East Anglia), at 2.30.—H. Balfour: Tasmanian Stone Implements.—Miss Nina F. Layard: Recent Excavations on the Neolithic Site at St. Gertrude, Holland.

ROYAL METEOROLOGICAL SOCIETY (Anniversary Meeting), at 3 and 8.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Annual General Meeting.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at University College), at 5.—Sir Flinders Petrie: Glassmaking in Egypt.—Mrs. Brenda C. Halahan: Chiddingfold Glass and its Makers in the Middle Ages.—E. W. Hulme: The Interrelationship of the Glassmakers in Western Europe, Glassmaking under the Roman Empire.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: Some Effects of Climate on the Circulation (I.).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions made to the Society's Menagerie during the month of March, 1925.—F. Martin Duncan: Exhibition of an Improved Method of Illumination for use in Zoological Research.—F. G. S. Whitfield: The Relation between the Feeding-habits and the Structure of the Mouth-parts in the Asilidæ (Diptera).—R. I. Pocock: The External Characters of the Lagomorph Rodents.—A. Loveridge: Note on East African Batrachians collected 1920–1923, with Description of Four new Species.

INSTITUTION OF CIVIL ENGINEERS, at 6.—D. Paterson: The Johore Causeway.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Dr. K. C. D. Hickman: (*a*) A New Washing Tank for Plates, Paper or Films; (*b*) Notes on Uniform Development, and a Rapid Chemical Test for the Exhaustion of Fixing Baths.—Drs. K. C. D. Hickman and D. A. Spencer: The Washing of Photographic Papers.—O. Bloch: Note on the Under-Exposure Portion of the Characteristic Curve.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—C. Burrows: Designing Rear Axles for Production.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. Thom: Aerodynamics of the Rotating Cylinder.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Recent Excavations on Palæolithic Sites at Creswell Crags, Derbyshire.

WEDNESDAY, APRIL 22.

ROYAL MICROSCOPICAL SOCIETY (Conference at the University, Sheffield), in morning. (For Papers see April 20.)

ROYAL SOCIETY OF MEDICINE (British Congress of Obstetrics and Gynæcology), at 10.30 A.M.—Reports in Chief on the Prognosis and Treatment of Puerperal Sepsis.—Sir Ewen J. Maclean: Puerperal Sepsis in Wales.—Dr. G. Fitzgibbon and Dr. J. W. Bigger: A Clinical and Bacteriological Investigation of Puerperal Fever.—Dr. L. P. Lockhart: Bacteriological Examinations during Pregnancy.—At 2.30.—Prof. J. Whitridge Williams and others: Discussion on Puerperal Sepsis.

ROYAL METEOROLOGICAL SOCIETY (Anniversary Meeting), at 3.—Prof. E. van Everdingen (Lecture).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. L. F. Nuttall: The Stratigraphy of the Laki Series (Lower Eocene) of parts of Sind and Baluchistan (India), with a Description of the Larger Foraminifera contained in these Beds.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—Annual General Meeting of the Association of London Students.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at 6 Queen Square, W.C.1), at 6.—J. A. Knowles: Medieval Glass Painters' Methods of Using Cartoons.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at 244 Deansgate, Manchester), at 6.30.—G. W. Watson: Brakes for Motor Vehicles.

ROYAL SOCIETY OF ARTS, at 8.—C. Chivers: Bookbinding.

INSTITUTION OF CHEMICAL ENGINEERS (at Chemical Society), at 8.—A. M. O'Brien: Continuous Distillation of Petroleum.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London, 11 Chandos Street, W.1), at 8.30.—Dr. A. Wohlgemuth: The "Synthesis" of an Anxiety-Neurosis.

INSTITUTE OF CHEMISTRY (London Section).—W. Rintoul and others: Discussion on Library and Office Organisation for Chemists.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield).—Annual General Meeting.

THURSDAY, APRIL 23.

ROYAL SOCIETY OF MEDICINE (*British Congress of Obstetrics and Gynæcology*), at 10.30 A.M.—Prof. W. W. Chipman: Prolapsus Uteri, with Epidiascope Demonstration.—Dr. B. Solomons: The After-results of the Sub-peritoneal Gilliam Operation.—Dr. W. Shaw: The Relationship between Ovulation, Corpus Luteum Formation, and Menstruation.—Prof. J. M. Kerr: A Case of Pseudomyxoma Peritonei with Affection of the Appendix.—At 2.30.—Prof. J. W. Williams: Premature Separation of the Placenta.—Dr. M. Donaldson: The Treatment of Inoperable Carcinoma Cervicis with Radium.—Dr. G. I. Strachan: The Treatment of Carcinoma Cervicis with Radium.—Dr. Agnes Bennett: The Albuminurias of Pregnancy in the State Maternity Hospitals of New Zealand.—Prof. Louise McIlroy and Dr. E. P. Williams: The Toxæmias of Pregnancy from their Clinical and Chemical Aspects.

LINNEAN SOCIETY OF LONDON, at 5.—J. Parkin: A Unique Feature in the Petal of *Ranunculus*, with remarks on the Phylogeny and Taxonomy of the Genus.—K. Rees: Investigations into the Distribution and Ecology of Phæophyceæ in Wales.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Dr. H. Jeffreys: The Interior of the Earth (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—F. Kingdon Ward: A Year's Exploration in Tibet (I.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Lt.-Col. K. G. Maxwell and A. Monkhouse: Recent Improvements in the Insulation of Electrical Machinery.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House), at 7.30.—Buck and Hickman: Modern Machine Tool Methods.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates' Meeting) (at Luton), at 7.30.—P. F. Goffey: Supercharging.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 6 St. Martin's Place, W.C.), at 8.—B. D. Porritt: Some Problems of the Paint and Rubber Industries.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 8.—C. Bingham: Overheating in Acetylene Generators.

FRIDAY, APRIL 24.

ROYAL SOCIETY OF MEDICINE (British Congress of Obstetrics and Gynæcology), at 10.30 A.M.—Prof. A. Donald and Dr. K. V. Bailey: A Clinical and Pathological Study of Endometrioma, with Epidiascope Demonstration.—Prof. J. H. Teacher: Epidiascope Demonstration of the Implantation of the Human Ovum.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Prof. W. Wien: Recent Researches on Positive Rays (Guthrie Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Reports to the Hardness Tests Research Committee:—G. A. Hankins: The Effects of Adhesion between the Indenting Tool and the Material in Ball and Cone Indentation Hardness Tests.—G. A. Shires: Some Practical Aspects of the Scratch Test for Hardness.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saunders: Close up Portraits from the Zoo.

INSTITUTE OF METALS (Swansea Local Section) (at Swansea University College), at 7.15.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. E. Cowley: The Manufacture of Gramophone Records.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—B. Carr: Chromium Plating.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. T. Butterwick: Tonnage.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. W. A. Craigie: The Icelandic Sagas.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Dundee Technical Institute).—A. B. Mallinson and others: Discussion on Justifiable Small Power Plants.

SATURDAY, APRIL 25.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. P. Pycraft: Use and Disuse: Effect on Structure of Animals (I.).

PUBLIC LECTURES.

TUESDAY, APRIL 21.

KING'S COLLEGE, at 5.30.—Prof. W. Wien: Problems of Modern Physics. (Succeeding Lectures on April 22 and 23.)



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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2895, VOL. 115]

Health in the Tropics.

THE medical conference which was held in the West Indies during last summer was probably unique in the history of medical science in that it was organised by a purely commercial company. The delegates, amongst whom were many distinguished men, were the guests of the United Fruit Company, and it is a remarkable fact that a wealthy commercial undertaking, having its offices in New York, should have a Medical Department, and that its directors should accept the advice of the general manager of that Department to issue invitations to laboratory workers and clinicians belonging to many nations to attend, as the guests of the Company, a conference to be held in a colony of the British Empire situate in the West Indies.

The particular conference was specially charged with showing to the guests what the Company is doing to maintain the health of its employees in tropical America and with obtaining, by discussion, suggestions for still further improvement of the conditions of life. The lesson is of supreme scientific importance, and is one which should be learned by all those, whether of British or any other nationality, who are engaged in commercial enterprise in tropical lands. The United Fruit Company has realised that sanitation pays and has acted accordingly. It has had the will to do the things that are necessary and has recognised the fact that what cannot be afforded is to leave them undone.

Scientific investigation has revealed the method of spread of practically all the diseases which are liable to afflict the dweller in the tropics, and the means of controlling these diseases are well known. Yet such is the scepticism or lethargy of those in command that in many cases they refuse to recognise the fact that sanitation is a commercial proposition repaying all the trouble taken in hard cash, which is the ultimate aim of all business undertakings. It is to be hoped that the demonstration given by the United Fruit Company will be thoroughly appreciated and, what is more important, acted upon.

One of the principal topics of discussion at the conference was the possibility of the white man becoming an inhabitant of the tropics. It is often assumed that the wonderful advances in tropical medicine will make the tropics a suitable home for the white man, and that in days to come the tropics will displace the temperate zones as the centres of activities of the world. This appears to be the view of the majority of those present at the conference. They believe that the attainment of normal longevity is not difficult provided that industrious habits are maintained, restraint as regards indulgence in intoxicating liquors is practised, and venereal disease and parasitic infections—especially hookworm and malaria—are avoided. Sir

James Fowler[1] is convinced that even if these risks are met, over and above them all there is something which cannot be avoided. The crux of the whole problem appears to him to be the children, and he claims that if the Englishman is to become as much at home in the tropics as he is in England, he must be able to rear his family there. If he cannot do this he will certainly remain, as he now is, only a migrant.

Whichever of these two opposed views is correct, it still remains a fact that, by attending to sanitation and preventive medicine, a great deal can be done to diminish the sick rate amongst white men in the tropics Sir James Fowler points out that as regards the general sanitation of Jamaica, the municipal authorities stand condemned on every count, and should be replaced by an administration armed with powers adequate to the cleansing of such an Augean stable. In contrast, the farms of the United Fruit Company are described as sanitary oases in an unsanitary desert The Company owns the only possible hotels in Jamaica When it takes over an estate, its first procedure is to build a hospital, to erect mosquito-proof workmen's dwellings and farm buildings, to instal all necessary sanitary appliances and to establish a satisfactory water supply, so that everything required to protect the health of employees is ready on their arrival.

The report of the Medical Department of the Company for 1923 consists of 180 pages, and shows that there is a staff of 50 doctors, 43 registered nurses, and 442 workmen. Nearly every well-known university and medical college in the United States is represented among the personnel. In addition to the establishment of a highly equipped medical organisation, the Company has built churches and schools, has erected club-houses and amusement halls, and has provided athletic grounds, all of which contribute very largely to the creation of an atmosphere of content, without which the mental depression noted above creeps in and so lowers vitality that inevitable sickness results.

One of the diseases which requires constant vigilance in tropical America is yellow fever. Thanks to the investigations of the American Commission in 1900, it is known that the disease is carried by the black and white mosquito *Stegomyia fasciata* Noguchi has isolated from cases of the disease a spirochæte which he has named *Leptospira icteroides*. It has been recovered from cases in several distinct outbreaks of the disease, but, though Noguchi claims that in animals the organism reproduces the disease, there are some who doubt whether it is really the actual cause of yellow fever. Agramonte, one of the original members of the 1900 Commission, was present at the conference. He claimed that the only conclusive proof would be the reproduction of yellow fever in human beings by inoculation of a pure culture of the organism. He threw down the challenge to Noguchi and offered to produce the necessary volunteers. If the organism should prove not to be the cause of yellow fever, then there would be little argument for employing the serum and vaccine which are produced from it in the treatment of the disease.

The subject of yellow fever leads to Panama, for, as is well known, it was only as a result of the control of mosquitoes, the carriers of malaria and yellow fever, as organised by General Gorgas, that the construction of the canal became a possibility Here again is the same object-lesson—strict attention to the protection of employees from tropical diseases alone rendered possible this great achievement. The work accomplished, the question arose as to whether there was justification for the enormous expenditure of money which the maintenance of the sanitary condition involved. In June 1921 there arrived on the Isthmus a special Panama Canal Commission appointed by the Secretary of War. It consisted of a Brigadier-General of the Army, a Captain of the Navy, and two business men They recommended that the amounts expended for sanitation in the Canal Zone be greatly reduced, and if, as a result, the sick and death rate from malaria rises above the average in twenty of the largest cities of the United States, the sanitary precautions be increased. This recommendation was not accepted by the Secretary of War, but nevertheless attempts were made to reduce expenditure The reductions chiefly concerned Silver City, and the result was that in 1922 there was more than five and one-half times the usual incidence of malaria.

Another danger arises from the settlers, those discharged labourers who have been given a portion of land to cultivate The result of this policy, again, has been a large increase in the number of cases of malaria among non-employees who are widely scattered over the available parts of the Zone. It is estimated that 650 families are now living on the land in this way. This population is difficult to control, and is liable to form a reservoir of malarial infection which will become a danger to those whose work requires them to be exposed at night in unsanitated areas. On the other hand, it is claimed that these settlers bring advantages in the increase and cheapening of food. It is evident that in such an area as the Panama Canal Zone and in the thousands of similar areas in all parts of the tropical world, the health of employees can only be maintained by the strictest vigilance, and the necessary expenditure has been shown by the United Fruit Company to be an investment which will bear the closest scrutiny.

[1] "An Impression of Jamaica and the Panama Canal Zone." By Sir James K Fowler Pp 60 (London Eyre and Spottiswoode, Ltd., 1924.) 2s.

Tropical Timbers.

Timbers of Tropical America. By Prof. Samuel J. Record and Clayton D. Mell. (Published on the Foundation established in memory of Amasa Stone Mather of the Class of 1907, Yale College) Pp xviii+610+50 plates. (New York: Yale University Press, London: Oxford University Press, 1924.) 10 dollars.

NEARLY the whole of this work is made up of descriptions of the trees and woods of tropical America by Prof. Record, professor of forest products, Yale University, and the remainder, on tropical American countries and their forests, is by Mr. Mell, tropical forester There are fifty pictures of forests, forest lands, individual trees, timber, and timber sections, and a very full description of seventy-five different families of trees, with full particulars of an innumerable number of different timbers. The whole forms a complete and up-to-date standard work, and is a very welcome addition to the somewhat bare library of books on the subject of the forests and timbers of the world.

Hitherto very little has been written either in regard to these forests or their timbers This especially applies to the timbers of Brazil, about which there has been the utmost confusion, and in regard to Guiana the same can be said, excepting for Stone and Freeman's "Timbers of British Guiana"

The introduction of Mr. Mell's work is particularly valuable, because he has been over a large part of this vast country and gained his information first-hand; while the author has made a very thorough and patient study of the woods under the most favourable conditions. These vast tracts of forest and the magnificent timbers which they contain, and the rapidity of the growth, give the reader some consolation when he reflects upon the enormous demand which the world at present exacts for supplies from more accessible sources; so that while half of the world is deploring the want of transport facilities to enable them to destroy forests, the other half can rejoice that such difficulties are wellnigh insuperable.

Bernard Palissy wrote in the sixteenth century:

"I am quite astonished at the ignorance of man, for it appears that to-day he only studies how best to destroy the beautiful forests that his predecessors guarded so sacredly . . . for after all the trees have been cut down it will be necessary for all the arts to cease. . . . I have often wished to make a list of the arts which would cease if there were no longer any wood, but when I had written down a large number of them, I found that there would be no end to the enumeration, and, after due consideration, I came to the conclusion that there was not even one trade which could be carried on without wood."

The "ignorance of man" has caused him also to fail to make sufficient, or almost any kind of, provision for the future. Paul Charpentier in "Timber" wrote:

"To-day the hand of man has used, in such a manner and for so long, the treasures of Nature without foresight that the greatest preoccupation of cultivators of forests —the question which ought to attract the attention of Governments most—is the replanting with trees of the land once occupied by forest"

There is no sufficient practice, if any, of re-afforestation taking place in America In Africa hundreds of thousands of giant trees have been cut down, and it is doubtful whether any scheme of re-afforestation in these dense tropical forests could be practised even if it was attempted, and in India and Burma, where scientific forestry has been practised for fifty-six years, no proper consideration has been given as to the planting of the most valuable sorts. The planting of mahogany has, for example, scarcely been seriously considered; yet in the Botanical Gardens of Calcutta there were three trees (*Swietenia mahogani*), one of which was felled for improvements in the gardens, and proved to be of the most beautiful quality, equal to the best in Honduras, two others which were felled especially to be shown at the British Empire Exhibition, one of which had apparently required only 113 years to produce a diameter at the butt of 6 ft 6 in., weighing 10½ tons, and containing 4007 ft of board measure; and the other in 89 years having produced 4 ft. diameter at the butt, 4½ tons in weight, and 1575 ft of board measure The quality of the wood in these two trees was excellent

Strange indeed it is that forest officers, only excepting in regard to teak in Burma and oak in Germany and Slavonia, have paid so little attention to the matter of providing for the future those trees which have been found to be so valuable in the past. The great French Minister Colbert said. "France will perish for want of wood." We should take his warning to heart, for, turning to Great Britain, in the past our reserves of forests have stood us in good stead, but our ash has gone, our oak is going, and the plentiful supplies of all kinds which have come to our rescue in times of national stress on more than one occasion will not be found in the future, unless we recognise the necessity of providing for our possible needs

It is true that the Government has organised a Forest Department which is doing good work; and so far as it goes, this is something to the good, but it is quite an inadequate measure. Even if this Department had far greater resources and power, government departments are always cumbrous and of necessity work slowly on somewhat extravagant lines.

In the Slavonian country, whether the forests belong to government, to municipalities, or to private persons,

all alike have to conform to a regular rule; that is, for every tree that is allowed to be cut, a certain number have either to be planted, or if natural regeneration is taking place, protected and preserved; so that every year the area of forest land is not only maintained but also actually increased.

We have yet to find out the disaster which we have suffered, and are still suffering, by the loss of our wealthy landed gentry; it will be felt in the future in agriculture, but in timber the loss will be far greater When at last all the great estates have been parcelled out, all the timber that can be sold will be cut to meet the levies of high taxation, and the real source from which our forest reserves have been accumulated will disappear. One of these great landowners not long since showed a vista of land from his house stretching for miles which in his grandfather's time was covered with trees of considerable value, but now the trees have altogether gone

Paul Charpentier said that the cultivation of forests was a question which ought to attract the attention of governments most, if government were to institute a well-devised scheme by which every owner of land, instead of being taxed because of plantations, was given a remission of taxation on that account, much would be accomplished The owner of land, whoever he may be, has a natural love for and desire to plant, but he is stopped from doing it because he knows he would be pounced upon by the revenue authorities. An excellent system is practised in Burma, under which the government lets out sections of land to growers of rice or "paddy", these parcels of land are let on an entirely nominal rental, and the tenant has to plant his trees under the direction of the forest officer After planting, the trees have to be tended and kept in good order, and at the end of a few years the ground is given up to the government and becomes forest, while the tenant moves on to another section.

The ignorance referred to by Bernard Palissy is largely due to the indifference shown in our educational work to the necessity for including forest subjects and a knowledge of trees as a study of first importance. It would be interesting to find what proportion of our population could identify even our own common trees. A greater knowledge would not only become of great national value, but would also raise the standard of the people's sense of the beauty of Nature.

This also suggests another phase, which is the extravagance of the British public in their use of timber Free imports and a fairly high rate of money exchange have made it possible for us to be extravagant in this respect, so that timber which is highly valued in France, Germany, etc, and used with great regard to economy for all kinds of purposes, is here considered unsuitable, and is used either for estate purposes or burned.

An Englishman visiting the timber yards on the Continent to-day is amazed to see the kind of material which is being used for decorative woodwork. In Great Britain, thousands of tons of highly selected timber of foreign origin are used in works where a much inferior quality would equally well serve the purpose, and so, while we fail to realise the importance of storing up a future supply for ourselves by wisely devised schemes of re-afforestation, we are also spendthrifts in regard to those supplies which we get from overseas It is consoling at any rate that in the country about which Prof. Record gives us so much information there is a large reserve

The book is arranged in order of families, with a summary following each kind, giving information for identification and comparison. The method is a good one for the student, but not altogether attractive to any who are not enthusiasts. It is a matter of regret that the admirable plan of showing forest areas by means of maps, adopted by Zon and Sparhawk in "Forest Resources of the World," has not been used here.

A bold pronouncement is made as to the source of real mahogany, when the author says: "Swietenia with five known species is the only source of true mahogany" (p 348). He apparently overlooks Mr. Herbert Stone's remark in "Timbers of Commerce," p. 32, where a different conclusion is reached, and one which the reviewer endorses.

The question of nomenclature of timbers must always remain an exceedingly difficult and complex one A certain latitude must be observed, and the use of the name "mahogany" is a case where a broad view should be taken There are other woods where the case is quite different. It would be absurd not to call African mahogany "mahogany," yet according to the author's pronouncement it is not mahogany at all. The same would not apply to a wood like teak, because there is only one teak—*Tectona grandis*—and no other kind of timber from any part of the world possesses its qualities or its real appearance, so that to add the name "teak" to any other wood is wellnigh fraudulent.

The name "mahogany" has, however, throughout many years become a general term, and it is very doubtful if what was first known as mahogany was *only* the produce of Swietenia The great similarity of so many other species is so remarkable that they can justly claim the right to the name.

The author attributes the slowness of the development of the general use of mahogany to the fact that the material was considered too difficult to work, but it seems more likely that the real cause was the pre-

judice which is invariably experienced in the introduction of any new timber, as well as the tax originally imposed.

Mahogany was first used by Cortez in 1521, by Sir Walter Raleigh in 1597, by Capt. Dampier in 1681, and first used in England for cabinet-making in 1754; yet we find that the greatest possible efforts were still being made in 1846 to persuade people to make more general use of this magnificent wood.

In a work which covers such a vast field it is not surprising that some debatable points should arise; for example, the author quotes a writer who states that East Indian satin wood is frequently confused with Prima Vera mahogany (p. 318), but even the amateur should not make this mistake, as there is a marked difference in texture and figure It is stated also that East Indian satin wood is paler in colour than that of Porto Rico and Santo Domingo, but while the variation in colour generally is similar, much darker wood can be found from East India than from West India. Again, it is probable that the scents produced when working West Indian, East Indian, and Concha satin wood are all alike; certainly the scent of all three when burning is similar, although perhaps this is not so pronounced in the case of the last two named, which provides a rather interesting subject for the botanist. It is doubtful also whether the author would be able to sustain the description of Concha satin wood (p. 318) as being an inferior grade of wood. The gum streaks which it contains have militated against its popularity in America, but in all other markets it is most favourably received, and in individual cases has actually been preferred, generally, size for size, and value for value, and has realised fully as much as the regular satin wood.

There has always been the utmost confusion in regard to Brazilian woods, largely on account of the repetition of names, and because similar names have been applied to entirely different species. For example, sixteen kinds of Canella are mentioned on p. 179, including *Canella batalha*, *limao*, and *preta*. These all belong to the *Nectandra sp*, but there is an entirely different species also called Canella, that is, the Wild Cinnamon, the source of which is *Canella winterana* There is no doubt that timbers of both species have been shipped on account of the name, regardless of which was required, to the utmost dissatisfaction of those who received them.

Prof. Record's specimen of *Pithecolobium vinhatico* is reported to weigh 37 lb. (p. 211). A brother of the well-known Mr. J. S. Gamble, who was many years in Brazil and got together a very exhaustive collection of Brazilian timbers, together with a host of information, produced a specimen of Amarello which he names as from the same source, but which weighs 49 lb. The reviewer identifies this wood as being the equivalent to the *Adenanthera Pavonina* of the Andaman Islands. Mr. Gamble also had a specimen which the reviewer named Vinhatico, but which Gamble names as *Symplocos sp.* Again, Gamble's specimen of *Angelim amargosa* weighs 49 lb., and is attributed to Anthelumthica. There is a specimen in Gamble's collection of *Arariba Rosa* to which the same source is given, weighing 40 lb. against Prof. Record's 55 lb There is a specimen of *Arœira do Sertao*, which was traced as being *Astronium urundueva*, and possibly Myrocrodon, weighing 69 lb.

Those who have never attempted the task would be astonished at the immense amount of time and work which is required to unravel the maze surrounding the identification of timbers and to trace them to their original source. This book is full of new information, so that the authors are to be congratulated upon the painstaking efforts they have made in bringing all this material together. Every one interested in the subject of forestry and timber will be anxious to possess it. A. L. HOWARD.

Foundations of the Theory of Optical Instruments.

Grundzuge der Theorie der optischen Instrumente nach Abbe Von Siegfried Czapski und Otto Eppenstein. Dritte Auflage. Bearbeitet von den wissenschaftlichen Mitarbeitern der Zeissischen Werkstätte: H. Boegehold, O Eppenstein, H Erfle, A. Konig, M v Rohr Herausgegeben von H Erfle und H Boegehold. Pp xx+747. (Leipzig: J A Barth, 1924) 30 gold marks

A THIRD and greatly enlarged edition of this work, the original material of which was written by Dr. Siegfried Czapski for Winklemann's "Handbuch der Physik," has now been completed by several of the principal scientific workers in the firm of Zeiss. The death of Ernst Abbe in 1905, followed by that of Czapski two years later, removed the original mastermind and also one who performed a great service in making Abbe's work and methods known to others

Although Abbe's theories are well known to-day, and the parts of the present volume which deal with them contain little that is unknown to English readers, the appearance of names like that of Prof. Moritz von Rohr amongst the collaborators is a sufficient guarantee that the new sections will not be lacking in originality. A case in point is the generalised treatment of the space presentation possible through different types of perspective and stereoscopic reconstruction in the use of binocular optical instruments.

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The volume contains some twenty-one chapters, mostly of considerable length, some are highly mathematical and "condensed," while others are of a more descriptive character, in which the discussion is apt to be a little out of proportion with the general character of the work The geometrical theory of instruments occupies the first ten chapters, a great deal of the treatment being similar to that which is now available in English through Mr. Kanthack's translation of the well-known book "The Formation of Images in Optical Instruments" (a symposium edited by Prof. von Rohr). The present work, however, has chapters on such subjects as diffraction phenomena and their relation to optical instruments, and the formation of images by non-spherical surfaces

The last eleven chapters contain general discussions and descriptions of such instruments as photographic lenses, hand magnifiers, microscopes, projection apparatus, and telescopes The important subject of practical optical measurements (curvatures, focal lengths, and the like) is unfortunately crowded into one chapter at the end, which will probably be difficult reading to any one who has not the knowledge necessary to supplement its brevity The aim of the authors has apparently been not only to furnish a presentation of the theory and facts, but also to include, wherever possible, references to all known published work bearing on the subject in hand, together with some comment on the results described in the papers thus cited. The effect is naturally a very considerable expansion of the discussion; the book will occupy for optics almost the place that Kayser's famous "Handbook" has filled for spectroscopy. Hence it is bound to prove, for this reason alone, a most useful work of reference for a person already well acquainted with the subject generally.

On the other hand, the work should be avoided by the beginner. It is certainly no royal road to the design and computing of optical systems, for the trouble in work of that kind is to know "where to begin" It is to be feared that the average student would be in the same difficulty after reading its seven hundred pages, even if he found time to do so He would also have some difficulty in deciding which were the parts of real practical importance and which were of merely mathematical interest. We are told at one place (p 242) that if several bendings of a lens are taken and the spherical aberration is plotted against the curvature of the front surface, a parabolic law is found. A serious student should put the book down at this point and work out the formula numerically to obtain data to plot the curve Unless this kind of thing is done, these formulæ are nothing but dancing figures.

No adequate attention is paid to the subject of the tolerances for aberrations. It avails little to be able to calculate the magnitude of a defect unless one has some idea as to what amount is allowable in relation to the particular circumstances The truth is that formulæ expressing aberrations in terms of ray intercepts are quite unsuitable for the discussion of tolerances except in cases where these are comparatively large. The matter can only be dealt with satisfactorily, as Prof Conrady has always maintained, by considerations of optical path.

It is, however, encouraging to find that the applications of the diffraction theory to the elucidation of the phenomena in the neighbourhood of a focus with or without aberration are beginning to receive the attention they deserve, and the necessary warnings are given on p 238, where transverse aberration and diffusion circles are discussed. The diffraction theory of spherical and chromatic aberrations receives a separate chapter, but although the recent theoretical and numerical work carried out by Conrady and others in this connexion is mentioned, the results are not included It would now appear that the statement on p 313 regarding the effect of spherical aberration is incorrect It is there maintained that increasing aberration will always diminish the resolving power of a lens system for an object like a double star On the contrary, it has now been shown that a smaller central image disc may be produced slightly away from the ordinary focus under some degrees of spherical aberration, this will actually give increased resolution in spite of surrounding "haze" It need scarcely be said that this is a practical point of the greatest significance, for it shows that high resolving power is not necessarily a test of the best optical correction.

The equation $nhu = n'h'u'$ is now styled the Huygens Helmholtz equation! Has ever an equation received so many names? If the claims of R. Smith and Lagrange are thus passed over, it might be shorter to call it the Huygens equation and end the matter finally in this way. While speaking of names it might be pointed out that Mr T. Smith, of the National Physical Laboratory, Teddington, the author of the papers to which references are given, should not be confused with Prof. T. T Smith.

The lapse of a few more years will make the inclusion of full references an almost impossible task. Has not the time arrived when authors should have the courage to set forth clearly what they consider to be the essential parts of a subject without including matter which, for the majority of users of their books, has little more than mere theoretical interest?

L. C. MARTIN.

Medieval Science.

Studies in the History of Mediaeval Science By Prof. C. H. Haskins. Pp xiv+411. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1924.) 28*s.* net

THERE are few words which can evoke such a wealth and variety of reactions as "medieval" To the average man, perhaps, it recalls glimpses of illuminated missals caught in a brief walk through the British Museum; the poet will murmur *Donne ch' avete intelletto d' amore*, while the philosopher will dream dreams of the schoolmen and their interminable arguments. In the phrase "medieval science," however, many men of science of to-day will see nothing but a contradiction in terms, for it is a widespread idea that the Middle Ages stood for the very antithesis of all that is implied by the method and outlook of science as we understand it. Yet it requires but a little patience and insight to realise that, even in those remote and difficult times, the true spirit of science was awake and full of vigour.

The obstacle that so often prevents us from estimating early scientific work at its true value is essentially twofold In the first place, only a fraction of the literature of the subject has been rendered easily accessible To appreciate fully the labours of a medieval natural philosopher therefore entails no little research into original documents, a task for which few men of science have either the time or the inclination Scholars and historians, on the other hand, are as a rule not interested in scientific literature, and even if they were, they usually lack the necessary knowledge of science From this *impasse* there appears to be only one escape: historical research in science must receive full recognition as an integral part of science itself. We shall then very quickly attract the necessary men, and shall obtain results which will prove of incalculable benefit not only to science but also to the whole cause of human civilisation. A start in this direction has fortunately already been made at the University of London; other universities cannot afford to be left behind.

The second difficulty is not quite so easy of solution. In brief, it is that scientific thought is bound to vary, not merely in content, but also in form and character from age to age, for it must necessarily be influenced by the general intellectual background of the time This influence is, of course, reciprocal, but if the philosophy and habits of thought of a particular age are very different from our own, we are inevitably led to judge the scientific work of that time by standards which are in reality quite inapplicable. In chemistry, for example, it is easy to place a true value upon the work of Lavoisier and Dalton, for their ideas, aims and methods are fundamentally our own. It is much more difficult to appreciate the outlook and achievements of Becher and Stahl; our equipment of facts is so great that we find it practically impossible to denude ourselves sufficiently. When we go back to still earlier times, the difficulty becomes well-nigh insuperable The whole intellectual *milieu* is foreign to us; we can understand neither the aspects of the problems which presented themselves nor the mental satisfaction of the solutions which were suggested

An immediate key to this perplexing matter is that gift of sympathy which enables a man to transport himself to the Middle Ages and share the thoughts and aspirations of Gerard of Cremona, Adelard of Bath, and their contemporaries. This gift, alas, is all too rare, but if those who have it will translate their experiences into language intelligible to the rest of us, we may succeed in acquiring it at second hand. If, in addition to sympathetic insight, a man possesses also a sound scholarship, we may expect from him a flood of light upon medieval science. Such a man is Prof Haskins, and his book justifies our anticipations

As Prof Haskins remarks in his preface, the history of European science in the Middle Ages is twofold In the first place, it must deal with the recovery and assimilation of the science of antiquity in the course of the twelfth and thirteenth centuries, secondly, "it has to take account of the advance of knowledge by the processes of observation and experiment in western Europe" The scientific renaissance of the twelfth and thirteenth centuries was a very remarkable event, and at present very little is known about it, except that it certainly happened Its importance can scarcely be exaggerated, for it appears that at least two new sciences were actually introduced into Europe during that time, namely, algebra and chemistry

In the transmission of ancient learning from Islam to Europe, Englishmen played a prominent part. Adelard of Bath, for example, who has been called "the greatest name in English science before Robert Grosseteste and Roger Bacon," was a prolific translator of mathematical and astronomical works from the Arabic Prof Haskins has collected together all the available information about this rather shadowy figure, and we are surprised at both the extent and depth of Adelard's scientific knowledge. It is particularly interesting to learn that he shows the influence of the atomic theory of Democritus, for atoms were generally at a discount during the Middle Ages. He possessed a rationalistic habit of mind and subordinated authority to reason. "I call myself a man of Bath," he says, "and not a Stoic, wherefore I teach my own opinions, not the errors of the Stoics." Other Englishmen who

engaged in the task of translation were Robert of Chester (who is said to have translated for the first time a book on chemistry), Roger of Hereford, and Daniel of Morley.

Although the main stream of translations came from Moorish Spain, Prof. Haskins does not neglect the subsidiary sources. Some Arabic knowledge, for example, came direct from Syria; a great deal more was transmitted through Sicily, especially during the time of Frederick II., to whom and his famous astrologer, Michael Scot, two chapters in the present book are devoted. In spite of his busy political and military life, Frederick found time to take an intelligent interest in the scientific thought of the day, and had sufficient independence even to correct Aristotle when experience proved that the prince of philosophers was wrong "we have followed him where required, but not in all things, for we have learned by experience that at several points he deviates from the truth." To disagree with Aristotle in the thirteenth century required a not inconsiderable moral courage Frederick's experiments were numerous and occasionally startling, but they were always devised with a definite aim He exploded the old fable that barnacle geese were hatched from barnacles by the simple expedient of sending north for some barnacles, while "whether vultures find their food by sight or by smell he ascertained by seeing their eyes while their nostrils remained open"

On Michael Scot, Prof. Haskins has a good deal new to say, and in many instances he is able to correct earlier writers Scot worked both in Spain and in Sicily, and did much to make the *De animalibus* of Aristotle known to the Western world His connexion with alchemy is doubtful, although many works on this subject are attributed to him As an astrologer, however, he became famous throughout Europe To test his skill in astronomy, Frederick ordered Scot to "calculate the height of the starry heavens—whatever that may mean—by the tower of a certain church, and then had the tower cut off somewhat and casually brought Scot back to the site. Scot took his observation and answered that either the heavens were more distant or the tower had sunk a palm's measure or less into the earth, both of which were impossible, whereupon the emperor embraced him in admiration of his skill"

Prof Haskins, it will be observed, while writing primarily for the specialist, has seasoned his pages with many a pleasant anecdote, and the general reader may skip the footnotes (and the passages in Latin if he likes) and still gain profit and enjoyment from his reading. To the historian of science, however, the work will prove invaluable. The full bibliographical references alone are worth careful study, for Prof Haskins knows his literature, both printed and manuscript, as few others can do. The help which is provided in this direction will prove as attractive to the scholar as will the interesting information on falconry (Chaps. xiv. and xvii.) to the plain lover of the Middle Ages.

Medieval science, it is true, often appears to us to be puerile, but that is because we view it from the wrong angle. Our system of orientation has changed, but science is a living tradition firmly rooted in the past. Let us put ourselves in the place of these medieval men of science, and we shall form a better conception of their services to the cause. "La nature," says Hoefer, "est aujourd'hui ce qu'elle était autrefois. Les anciens avaient les mêmes yeux que nous pour la voir, mais ils n'avaient pas la même manière de la comprendre: *la pensée humaine, voilà ce qui varie*"

E. J. HOLMYARD.

Our Bookshelf.

Department of Marine Biology of the Carnegie Institution of Washington. Vol 20· American Samoa. Part 1: Vegetation of Tutuila Island; Part 2: Vegetation of the Samoans; Part 3: Vegetation of Rose Atoll By Prof. W A Setchell (Publication 341.) Pp. vi+275+37 plates. (Washington. Carnegie Institution, 1924.) 3 50 dollars

THE Carnegie Institution has again materially added to our knowledge of the vegetation of the more outlying parts of the world by the publication of three treatises on American Samoa by Prof W A Setchell. The first and third parts are devoted to the vegetation of two islands, Tutuila and Rose Atoll, and provide a comprehensive review of the nature and distribution of the flora and enumerations of the species recorded. In addition to his own work, the author has incorporated that of previous workers in this locality, and has received the assistance of specialists in the description of the general habitat factors and the enumeration of the species

In all too few cases have we records of this nature. Throughout the tropics our information on the vegetation is so frequently only to be found as a brief sketch in the introduction to an official handbook or guide. It is by the aid of such unit works as Prof Setchell's that we shall gradually be able to obtain a due appreciation of the vegetation of such areas and, by piecing such units together, acquire sufficient knowledge to map out the vegetational areas and their connexions that are at present unknown. In each of these discussions the author has described the general habitat factors and then sketched the vegetation in its broader aspects and, where data have permitted, in more detail. This analysis has been based on the phanerogams recorded, for, as he remarks, our knowledge of the cryptogams is not sufficient at present to assist in this direction.

In an interesting review of the affinities of the Samoan flora, the author gives some negative characteristics which indicate the probability of an insular flora of the Pacific, though, as he points out, there is still much to be studied in this direction. Only eight new species

are recorded among the phanerogams, but there are a considerable number of new cryptogams, especially algæ.

The second treatise is devoted to the ethnobotany of the Samoans, and provides a record of the economic uses to which plants have been put. It is becoming more and more difficult, as civilisation transforms the habits of native races, to obtain such information, and any such records are to be welcomed.

An index of Samoan plant names is given in addition to the botanical index and greatly enhances the value of the work. There are thirty-six photographic reproductions in addition to text figures.

The Ethnography of South America seen from Mojos in Bolivia. By Erland Nordenskiold. (Comparative Ethnographical Studies, 3.) Pp. vi + 254 + 30 maps (London: Oxford University Press, 1924.) 18*s* 6*d*. net.

THE third part of Baron Nordenskiold's comparative ethnographical studies of South America is in some respects the most interesting of the series. It is an illuminating example of the use to which, in skilful hands, distribution maps can be put in elucidating the cultural history of an obscure ethnographical area. In north-east Bolivia there is a large number of tribes, some belonging to recognised linguistic groups, others speaking isolated languages. The explanation of the considerable differences in culture among these is to be sought in their history rather than in the influence of geographical conditions which, broadly speaking, are identical throughout. The country consists for the most part of plains, which at one time in parts were subject to inundation. Hence mounds were erected for purposes of cultivation. The Seriono, who represent the most primitive stage among the tribes, alone raised no crops and subsisted by hunting. The tribes now have iron; the stone which they formerly used was all imported as there is none in the country. It is interesting to note that a stone-grinding industry still exists.

In his valuable analysis of their culture the author has plotted the distribution of such elements as dwellings, cultivation, hunting implements, weaving, fishing weapons, appliances connected with fire and the like. The result is a mass of valuable information relating to each. In addition a number of general conclusions emerge; thus while there are evidences of a cultural influence from the west and especially the north-west, only a few of the numerous elements of western culture which are found in the Chaco occur in N.E. Bolivia. As might be expected, the small tribes speaking isolated languages represent a very old stratum from which elements have been adopted by Arawak and Guarani. On the other hand, many of the tribes show signs of having been influenced considerably by the Guarani.

Lighting in Relation to Public Health. By Prof. Janet Howell Clark. Pp. 185. (Baltimore, Md.: Williams and Wilkins Co., 1924.) 4 dollars.

THIS book is intended to suit the needs of the public health worker, and is a recapitulation of the course of lectures delivered to students studying for the degree of doctor of public health at the Johns Hopkins University. The first four chapters deal with the technical side of illumination, and succeed in conveying a very good account of the methods to be adopted in light measurement, and also of the advantages and disadvantages of the various illuminating systems, and one which easily can be followed without any special technical knowledge. The next three chapters deal with the questions of glare, sufficient illumination, and the best conditions for visual efficiency, the last including a brief account of the important work of Ferree and Rand on the measurement of ocular fatigue. Other chapters describe the best methods of illumination for schools, factories, and other interior and exterior purposes.

As regards intensity of illumination the author points out that though visual acuity, as tested by letter charts, increases with illumination and reaches a maximum at about 5 foot-candles, speed of discrimination increases rapidly up to 2 foot-candles and after that more slowly, but is still increasing at 18 foot candles. Thus, in occupations where speed of discrimination is required, light up to 20 foot-candles may be employed with advantage. The remainder of the book gives a brief but good account of eye diseases attributable to light conditions, such recent work as that of Healy, Cridland, and St Clair Roberts on cataract in tinplate millmen, iron-smelters, and chain-makers receiving mention. Some recent experimental work by the author on the coagulation of egg albumin by ultra-violet light is quoted as lending some support to Burge's theory on the causation of lens opacity.

We can cordially recommend the book as an adequate handbook to a subject that has only recently begun to obtain the attention it deserves. The publishers are to be congratulated on the excellence of both illustrations and type.

Timbers: their Structure and Identification. By W. S. Jones. Pp. xi + 148. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 15*s*. net.

THIS handbook is intended for forestry students who are engaged in a course of microscopical work on a selected group of timbers, comprising 24 European, 26 Indian, and 7 American broad-leaved trees, and 14 genera of conifers. The methods of preparing sections and microphotographs for the elucidation of structural details are carefully explained, as well as illustrated by 165 figures in the text. The lack of a comprehensive key to the whole of the genera is regrettable. The genera Salix and Populus, for example, are not distinguished in p. 73. It was scarcely worth while reprinting on p. 35 Hartig's inadequate key of forty years ago. An effort should be made in the next book that is published on the identification of timbers, to combine in one table the various keys that have been published of late years, notably Kawai's diagnosis of 200 species of Japanese broad-leaved woods and Kanehira's elaborate tables of 386 species of Formosan woods and 100 species of the more important Indian woods. Koehler's identification of North American woods, which appeared at Washington in 1917, might also be consulted. Without some such general view of the distinguishing characters of numerous species of woods, the palæobotanist, the archæologist, the timber merchant and the furniture dealer are put to great inconvenience in determining with accuracy unknown specimens of woods. This handbook, nevertheless, may be recommended to students who are interested in the structure of timbers.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Permo-Carboniferous Glaciation and the Wegener Hypothesis.

IN a recent number of NATURE (February 21, p 255) there is a very interesting review by Prof J W Gregory of an English edition of "The Origin of Continents and Oceans," in which important objections are brought forward against the supposed drift of continents and shifting of the earth's poles The suggestion is made, however, that the theory will "probably give a new lease of life to the explanation of the Carboniferous glaciation of India and some parts of the Southern Hemisphere, by the shifting of the Pole, for arguments, which are unanswerable against that explanation with scattered continents, do not apply to Prof Wegener's single continent"

The same view is held by Dr du Toit, who has done excellent work in investigating the Dwyka glaciation in South Africa

In preparing a forthcoming work on ancient glaciation, I have made a detailed study of the Permo-carboniferous ice age, and have reached conclusions which are quite at variance with this idea

In the first place, it has been proved that ice sheets on all the continents supposed to unite about the south pole *reached sea level* This is true of India, South Africa, South America and Australia, and in the latter two the ice touched the sea on both sides of the continent, as proved by fossiliferous marine deposits associated with the tillites

The usual idea of a vast and lofty Gondwanaland on which an enormous ice sheet could arise must be given up, for the different glaciated areas were separated by oceans or at least by arms of the sea in which marine animals survived

In the second place, an examination of maps of the supposed south polar continent prepared by Prof. Wegener (German edition) and Dr du Toit shows an area of land far greater than Eurasia at present, with glaciation reaching a latitude of at least 45° on more than one lobe In the case of South Africa, all the known ice motion was *southward* and it is evident that the northern half of the African ice sheet has not yet been worked out, since the region is forest-covered and almost unexplored It is altogether probable that ice reached as far to the north as it is known to have moved toward the south. This would carry the ice sheet at least ten degrees beyond the region mapped, say to latitude 35°.

It should be remarked further that, in most of the supposed Gondwanaland, as shown on the two maps mentioned, the glaciated areas would be far inland and out of reach of the moisture-laden winds necessary to deposit snow They would be arid regions without permanent snow fields, like the interior of Asia, which was not glaciated in the Pleistocene though one of the coldest regions of the world

It is evident, then, that the drift of continents and the shift of the poles do not help us to account for the Permo-carboniferous glaciation.

Prof Wegener's account of the causes of Pleistocene glaciation is even less in accord with the facts. His arrangement of the shifting poles and continents gives Patagonia a mild climate while Canada was being glaciated, and allows the ice to invade South America only at a much later time. A study of the American Pleistocene shows that two times of glaciation separated by an interglacial period occurred all the way along the Cordillera from Alaska to Tierra del Fuego, even Peru and Bolivia showing two sets of old moraines of different ages on the loftier peaks of the Andes. All geologists who have examined the Pleistocene deposits in South America as well as those of the north are agreed that they are of the same age and not separated by a million or more years as demanded by the theory of shifting poles

It may be confidently stated that a careful study of the two greatest periods of glaciation known to geology gives no support to the theory of the drift of continents and the wandering of the poles

A P COLEMAN

University of Toronto

I DID not mean to suggest that the lengthening of the life of the hypothesis would prove its truth, as I agree with Prof Coleman in doubting the shift of the Pole in Carboniferous times, but the popularity of the theory will probably be increased by the removal of one line of argument against it

J W. GREGORY

International Co-operation in Phenological Research.

THE response to our orginal appeal (NATURE, Oct. 25, 1924, p 607) has been gratifying Offers of co-operation range from Norway and Lithuania to Cape Colony and Australia, from Vancouver, Winnipeg, and Fargo (N Dakota) to Lahore, Calcutta, and Batavia (Java) It has brought us into touch with many workers previously unknown to us, and ancient records, including an almost unbroken series carried on in the same family, on the same system, in the same place, from 1737 to the present day We should like therefore to put forward for mutual discussion suggestions for future co-operation

The plant observations made independently in different countries have been selected naturally from those best fitted for comparison with crop growth in the given country In the same continent these lists include several common to all, allowing of a certain amount of inter-correlation We must aim so to select the number that not only continental but intercontinental correlations will be established on a firm basis. When this is done, important equivalencies (such as Dr. A D Hopkins' classic example of wheat sowing and the Hessian fly) will become available over world-wide areas, where now they can only be applied locally, although he has already shown possibilities, particularly between the United States and Western Europe

For this purpose we would suggest tentatively that an international list, including some forty subjects for observation, be drawn up, which might be expected to embrace at least some twelve to twenty fairly common in each of the associated countries, at least when situated in the temperate zones. Even ten, well distributed over the growing and fruiting months, would serve well for correlation

For this purpose garden as well as wild flowers must be utilised, as being so widely introduced, though a number of the commonest are unsuited because of the many varieties in cultivation, and consequent variation in dates of leafing, blooming, and fruiting.

If such an international list is drawn up and each country collects and digests the results through its own Association, then in ten years or so statistics

will have been brought into existence adapted to international comparison and the time will have come for the yet closer international co-operation already established in allied natural sciences such as meteorology.

Meantime each country would continue its present series of observations, while the observing members would be invited to observe also, either as a separate series or embodied in their own lists, a selection from the international list most available and not already under observation

That there may be a basis for discussion the following list has been drawn up from those actually in use in Italy, the Tyrol, Central Europe, and Great Britain Criticism and alternative suggestions will be highly valued.

PHENOLOGY AND AGRICULTURE

Suggested observations to correlate series A and B

A FARM GROWTH PHENOMENA

(1) *Grain crops*, dates of sowing (autumn and winter), appearance, ears showing, flowering, harvesting

(2) *Root crops* (say sugar beet) sowing or planting, appearance, digging

(3) *Meadow hay* flowering of sweet vernal grass (*Anthoxanthum odoratum*) and Timothy grass (*Phleum pratense*), hay-cutting

B. FLOWER PHENOLOGY of wild and garden flowers of wide distribution Tentative list arranged by approximate date (day of year) of flowering in Great Britain

	Common and Botanical Names	Day of Year
1	†Snowdrop (*Galanthus nivalis*)	19
2	†Winter aconite (*Eranthis hiemalis*)	20
3	Yew (*Taxus baccata*)	30
4	†Yellow crocus (*Crocus aureus*)	33
5	Common elm (*Ulmus campestris*)	44
6	*Hazel (*Corylus avellana*)	44
7	†Celandine (*Ranunculus ficaria*)	47
8	*Coltsfoot (*Tussilago farfara*)	65
9	Cherry plum or purple variety (*Prunus cerasifera* or var *P Pissardi*)	70
10	Bracken (*Pteris aquilina* (shows))	80
11	Almond (*Prunus amygdalus*)	85
12	White poplar (*Populus alba*)	85
13	Black poplar and Lombardy poplar (*Populus nigra* and var)	90
14a	*Wood anemone (*Anemone nemorosa*)	92
14b	Goat willow (*Salix caprea*)	100
15	*Blackthorn (*Prunus spinosa*)	102
16	Flowering currant (*Ribes sanguineum*)	110
17	Sessile fruiting oak (*Quercus robur*)	115
18	Stem fruiting oak (*Quercus pedunculatus*)	115
19	Red currant (*Ribes rubrum*)	115
20	*Garlic hedge mustard (*Alliaria officinalis*)	120
21	Crab apple (*Pyrus malus*)	130
22	*Horse chestnut (*Æsculus hippocastanum*)	133
23	Common lilac (*Syringa vulgaris*)	130
24	Quince (*Cydonia vulgaris*)	135
25	Laburnum (*Cytisus laburnum*)	138
26	*Hawthorn (*Crataegus oxyacantha*)	139
27	Raspberry (*Rubus idæus*)	150
28	*Ox-eye-daisy (*Chrysanthemum leucanthemum*)	154
29	Elder (*Sambucus nigra*)	160
30	*Dog rose (*Rosa canina*)	163
31	Snowberry (*Symphoricarpus racemosus*)	163
32	Guelder rose (*Viburnum opulus*)	165
33	*Black knapweed (*Centaurea nigra*)	190
34	Madonna lily (*Lilium candidum*)	195
35	*Greater bindweed (*Convolvulus sepium*)	198
36	Sweet chestnut (*Castanea vesca*)	200
37	Montbretia (*Tritoma montbretia*)	200
38	Autumn crocus (*Colchicum autumnale*)	245
39	Autumn Caucasian crocus (*Colchicum speciosum*)	250
40	*Ivy (*Hedera helix*)	276
41	Winter (yellow) jasmine (*Jasminium nudiflorum*)	280
42	Christmas rose (*Helleborus niger*)	350

* These twelve are in the Roy. Met. Soc. chief phenological list, observed from 1891.

† In supplementary list.

Even if only a dozen can be used, their value would be material.

Grain Crops.—Possibly the British Ministry of Agriculture will supply agricultural colleges, etc., every year with seed specially grown. Every year the various stages of a given sort should be observed on the same plot

For No. 22, and if possible with other trees, the leafing, fruiting, colouring, and leaf-fall of the same specimen or group should be recorded.

No 9 On seven years' records at Purley these were identical in average date

Nos 17 and 18. Which is most widespread?

No 26 In more southern areas, as Tyrol and Italy, unfortunately displaced by the later *C monogyna*

As ushering in the second quarter of this century, 1926 naturally suggests itself as an appropriate year for starting such co-operation Work would therefore begin next December in the northern hemisphere, and the following June in the southern

One very valuable help at the present stage in criticising the list will be to forward us the names of such of the forty or so as could and would be observed in different districts and countries

J EDMUND CLARK,
Sec., Roy Met Soc Phenological Committee
Royal Meteorological Society,
49 Cromwell Road,
South Kensington,
London, S W 7

Depth-recording with Plankton-nets.

IT is well known that there is great variation in the vertical distribution of various plankton organisms, but up to the present the actual depths from which net-collections have been made has never been known with certainty To help in the study of the vertical distribution of marine zoo-plankton, the Admiralty very kindly sanctioned the loan of an instrument which records graphically, on a drum worked by clockwork, the depth at which a net has been fishing during the whole of its period under water Results obtained with this apparatus indicate the necessity for an accurate knowledge of the depth at which the net has fished

While collecting last year I used the recorder regularly, and a few facts have come to light as to how the net behaves when fishing

The net in use was that known as the ring-trawl, a conical bag 9 metres in length, with a diameter of 2 metres at the mouth It was made of "stramin" (hemp-sacking *ca* 16 strands to one inch) To the end of the net was attached a galvanised iron bucket. It was towed on a single warp of 2-inch (circumference) wire from the port drum of the large trawl winch. At the junction of the bridle with the warp was attached a weight of ½ cwt on a short length of rope, and at this junction also was fixed the depth-recorder.

When a net is being towed, there are three main forces in action: the forward and slightly upward pull of the boat, the downward pull of the weight, and the backward pull of the net, wire, etc. Whereas the force due to the weight is constant from day to day, the two remaining forces depend upon the rate at which the net moves through the water, this in turn is dependent upon the rate of the towing-ship through the water, not over the ground, and the clogging of the meshes of the net The speed of the ship through the water is influenced by the strength of the wind and, when the net is fishing deep, by the drift, if any, of the surface water relative to the deeper layers

The ship from which we work is a large wooden steam-drifter, the s.s *Salpa*; when fishing with the above net the engine is used as motive power, except when the wind is so strong that it is possible to drift. The ship generally steams with the wind behind, because if she towed against the wind at the slow

speed necessary, she would be constantly falling off to either side, so necessitating extra manœuvring to prevent the warp coming under the stern and fouling the screw.

Under favourable conditions the engine is run dead slow; that is, as slow as it will run without stopping. It is the practice for the captain, as near as he can judge, to keep the angle of entry of the warp into the water constant (*ca* 40°) It is probable that by this means the filtering of the net will be as nearly the same as possible from day to day, as it must mean that the speed of the net through the water is fairly constant, and catches made on different days should therefore be comparable quantitatively.

This constant speed can be kept by adjusting the revolutions or actually stopping the engine for a few moments as the angle of the warp changes

Working in this manner through a large number of hauls, the graphic records of depth of fishing have

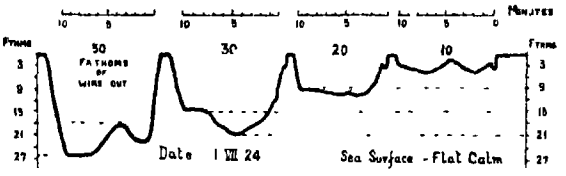


FIG 1

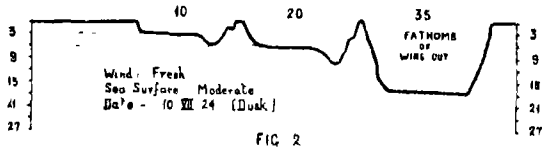


FIG 2

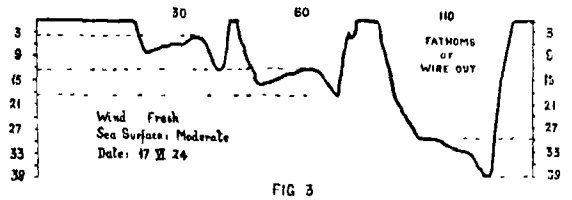


FIG 3

FIGS. 1, 2, and 3 are tracings of records obtained during three series of hauls. Each haul, represented by a curve, is of ten minutes' duration (time of "shooting" and "hauling" not included). The net enters the water on the *right hand* side of each curve. Above the curve for each haul is inserted the length of wire used in fathoms.

shown very varying results. On some occasions the net has followed a wavy path, fishing through as great a vertical range as 9 or 10 fathoms on others, the level kept by the net has been as perfect as could be wished for. Further, the seemingly paradoxical facts have arisen that on a day when the sea surface was like glass and conditions seemed most favourable, one of the worst results was produced, whilst under conditions of wind and swell such that work was almost abandoned, and furthermore in semi-darkness, the level kept by the net was as good as any obtained. These two instances are illustrated in Figs. 1 and 2; these tracings represent two series of hauls each of ten minutes' duration, and should be read from right to left, the net entering the water on the right-hand side of each curve and leaving it on the left. In Fig 1 the haul with 30 fathoms of wire out is an example of a bad result in this instance the net began fishing with the engine at the usual "tow-net" speed, but after five minutes, the angle of incidence of the warp appearing visibly greater than that usually kept, the engine was speeded up slightly, with the result that the net, which had sunk to 21 fathoms, was now slowly raised to a level of 15 fathoms, where it remained until the end of the haul. This behaviour is a little hard to understand when we look at the haul with 20 fathoms of wire out, here the net was towed with the engine at the same speed as at the beginning of the haul we have just examined, but instead of sinking, as it did on that occasion, it remained nearly level, rising very slowly throughout the duration of the haul.

Fig 2 illustrates the curiously perfect results obtained in very unfavourable circumstances.

It seems quite probable that if no attempt be made to adjust the angle of incidence with the engine, the net will find an equilibrium level, under the weather conditions prevailing at the time, and will fish there. This may account for the good results shown in Fig. 2, in which case the equilibrium level was found when the warp was at the angle usually aimed at. Therefore to fish a net at a constant level under different conditions of wind and sea, the length of warp required to keep the net at a given depth will vary considerably; how much this variation may be has been shown by some of my results. For example, in Fig. 1, in the haul with 30 fathoms of wire out, if the warp had not been watched and the net had been allowed to find its own level, it would possibly have sunk deeper than it did, as it was, it had reached a depth of 21 fathoms, and this with 30 fathoms of wire out, so that the ratio of depth to warp out was 2 . 3. In Fig 3, however, with a very fresh wind blowing, it was not possible, even without the engine, to keep the angle of incidence of the warp anywhere near that at which we usually aim If we look at the curve for 30 fathoms of wire out, we find that on one occasion the net rose as high as to 4 fathoms; this gives a ratio of 2 . 15, very different from that cited above.

In two cases the angle of incidence of the warp was measured as accurately as possible, and in both cases the depth estimated from the angle, on the assumption that the warp followed a straight line from the ship to the net, was very different from that actually shown by the recorder; in one case the estimated depth was 20 fathoms and the actual depth 14

From the above results it would seem that with large tow-nets of the type used in this case, it is impossible to estimate the depth of the net with a sufficient degree of accuracy, at any rate for coastal work on plankton distribution. Possibly with small nets, a weight out of all proportion to the size of the net will keep the wire nearly vertical and the net steady, but with large nets like the ring-trawl, the weight would of necessity be too great for man-handling in everyday work.

This would point to the necessity of having some simple and easily manipulated recorder designed of small enough size to be used when a string of nets is being fished.

F. S. RUSSELL.

The Laboratory, Citadel Hill,
Plymouth, February 25.

Spectroscopic Evidence of *J*-Transformation of X-rays.

The relation between the atomic number of a radiator and the wave-lengths of its X-ray emission spectrum of *K*-series is generally assumed to be the regular one described by Sommerfeld's extension of Bohr's idea to X-ray spectra. Well-marked irregularities, however, have not received attention in

the literature of the subject; it is the object of this note to direct attention to them.

Fig. 1 shows the variation of the wave-lengths $K\alpha_1$, and KA (absorption limit) with atomic number (Z) of radiator from Z = 40 to Z = 60; the plotted values

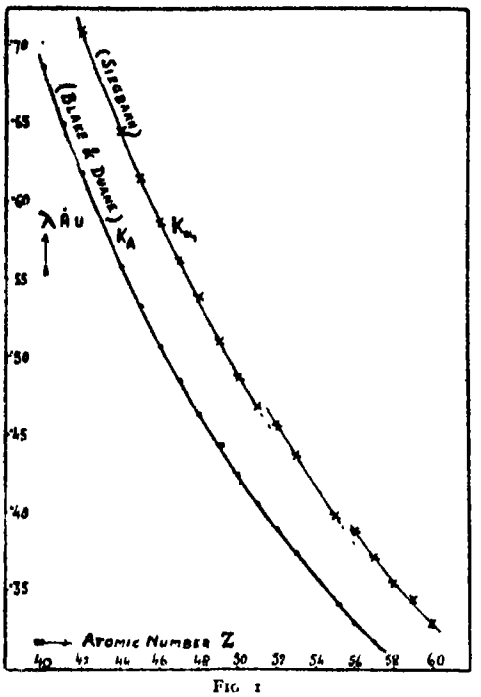


FIG. 1

are from Siegbahn, and Blake and Duane respectively. Fig. 2 is an enlargement of Fig. 1, to show more clearly the irregularities which we shall proceed to describe. If we follow λ for $K\alpha_1$, as Z is increased from 40, we notice that at Z = 52 and at Z = 56 there takes place a sudden increase in λ relative to the value which would have occurred, were the simple relation for smaller atomic numbers obeyed. The magnitude of this excess is about 0·01 Å.U in each case. Exactly the same irregularities occur in $K\alpha_2$ and $K\beta$, but not in KA. Lack of data prevents any definite conclusion with regard to $K\gamma$. The degree of precision claimed for these spectroscopic observations is too high to admit of any other conclusion than that these irregularities are real deviations from the simple law.

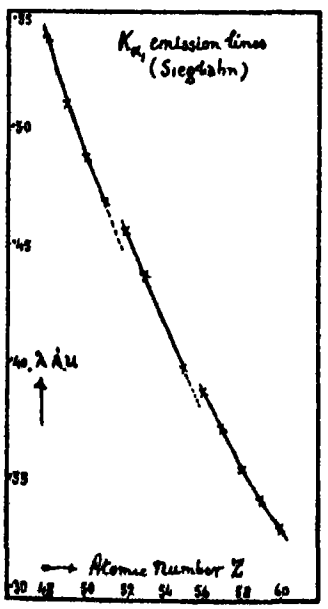


FIG. 2.

It is certainly no fortuitous coincidence that the wave-lengths at which these sudden increases take place, correspond very well with two of the critical absorbabilities for J-transformation, which in the case of aluminium are $(\mu/\rho)_{Al} = 1·9$ and 0·7 (see Bakerian Lecture by Barkla, Phil. Trans., 1917, and Barkla and Wnite, *Phil. Mag.*, 34, Oct. 1917), and are only very slightly displaced by change of the atomic number of the transmitting element except when this is small. The atomic structure of the radiator cannot be supposed responsible for the irregularities referred to, for, at the atomic numbers indicated, there is no re-adjustment of electronic distribution according to the Bohr scheme. As there is no reason, either theoretical or practical, for the occurrence of these irregularities, apart from the J-transformation, and as they appear precisely in the same place as in the experiments showing J-discontinuities, one can only conclude that these irregularities are due to the J-transformation of X-radiation taking place in the calcite crystal used for the analysis of the radiation or possibly in the anticathode or walls of the X-ray tube. We have, however, no information of the crystal used by Blake and Duane for the measurement of KA.

This seems to be the first spectroscopic evidence of the J-transformation, which by absorption methods has been found in primary rays (Barkla, Silvanus Thompson Lecture, NATURE, Nov. 22, 1924) and in scattered rays (Barkla and Khastgir, *Phil. Mag.*, 49, Jan. 1925). This also strongly supports the view expressed by Barkla (NATURE, Nov. 17, 1923, and Nov. 22, 1924) that the apparent increase of wave-length as observed by Compton and others in the scattered radiation is due to the same J-transformation during transmission in the crystal or in the radiator, and is not part of the phenomenon of scattering at all. That the magnitude of the change appearing in the curves shown here is of the order of the Compton shift, gives further support to this contention. It must be understood, however, that the attainment of a critical wave-length is not the only factor which determines whether or not the transformation takes place.

S. R. KHASTGIR
W. H. WATSON

Physical Laboratory,
University of Edinburgh,
March 27

Acidity produced in Salt Solutions by Sphagnum.

THE fact that Sphagnum or peat shaken with a neutral salt gives rise to an acid reaction in the solution has long been known. Baumann and Gully first explained this phenomenon as due to the adsorption of the base by colloids and the liberation of the acid. This view has been the subject of much criticism, especially by Odén, who regards the acidity as due to the presence of organic—humic—acids. An important argument of Odén is that no proof has been offered that the acid of the salt employed is ever present in the free state in the solution. We have been able to provide this proof by two different methods.

If a weak solution of copper chloride (0·025 per cent.) is shaken with Sphagnum it becomes acid to methyl orange. Colorimetric estimation shows that 75 per cent. of the copper has disappeared; determination of the chloride shows that it is still present in the original strength. The presumption is strong, therefore, that the acidity is due to free hydrochloric acid. As, however, the free acid, as estimated by titration, does not account for the whole of the chloride, the proof is not definite. It has been found that a secondary reaction resulting in the neutralisation of part of the acid takes place.

When the sodium salts of different acids are shaken with Sphagnum, different amounts of acid are liberated; much more acid is liberated from the acetate than from the chloride. It was found, on the other hand, that the hydrion concentration was much greater in the second case than in the first. The exact results for a

series of salts may be given. In each case 1·5 gm. of *S. cymbifolium* was shaken with 100 cc of N/10 salt. The acid was titrated with sodium hydroxide, and is expressed as a fraction of normality The borate was titrated after addition of manitol. The hydrion concentration was determined colorimetrically

Acidity produced in salt solutions by *Sphagnum cymbifolium*

Salt (N/10)	Titration Value	P_H Value
Sodium chloride	0 00026	4·6
Sodium sulphate	0·0005	4·6
Sodium acetate	0·0065	5·5
Sodium citrate	0 0085	5 9
Sodium borate	0 015	9 4

The fact that high titration value goes with low hydrion concentration is very suggestive A solution of sodium chloride and hydrochloric acid having the titration value shown was prepared and corresponding salt-acid mixtures of the other salts employed The hydrion concentrations of these were determined, and were found to be 4 6, 4 6; 5 5, 5·9, 9·5, respectively. The agreement is very satisfactory, and seems to give definite proof that the acid present in the salt solution after shaking with Sphagnum is, in fact, the acid of the salt employed The explanation of Rice, that a similar phenomenon in soils is due to the formation of acid aluminium salts, does not appear to be applicable here The further implications of these results will be dealt with in a later communication

MACGREGOR SKENE
GLADYS L STUART

Botany Department,
University of Aberdeen,
April 3

Three Cases of Abnormal Anterior Abdominal Veins in the Frog.

THE abnormalities here described were discovered during class dissection in this College Of fifteen specimens dissected three showed abnormality in the anterior abdominal vein All three specimens were females

Specimen A The anterior abdominal vein had no connexion with the liver, but emptied itself into the *left* subclavian vein

Specimen B Similar to A In addition there was a transverse anastomosis between the external jugular veins.

Specimen C The anterior abdominal vein sent a small vessel to the liver, but most of the blood passed into the *right* subclavian vein

The abnormal specimens showed no other peculiarities

Communications between the anterior abdominal vein and the right or left subclavian veins have been recorded by four observers, of whom three found one specimen each Buller (*Journ Anat. and Phys*, vol. 30, 1896) found in a female specimen a condition similar to C, but opening nearer the heart, namely, into the superior vena cava at the entrance of the subclavian into it Woodland (*Zool Anz.*, Bd 35, 1910) described the first abnormality (A) in a male frog, and O'Donoghue (*Zool Anz.*, Bd. 37, 1911) the same condition in a male specimen, coupled, however, with an abnormal heart Lastly, Collinge (*Journ. Anat and Phys*, vol 50, 1915) reported one case in which the anterior abdominal vein gave off a large branch to the hepatic portal system and then sent a fine vessel into the right anterior vena cava, and another case where both right and left venæ cavæ received contributions, no blood going to the liver from the anterior abdominal vein. The abnormalities here in question are probably of rare occurrence, and it is surprising to find them in 20 per cent. of a batch of frogs (3 out of 15).

The interest of the abnormality, as was pointed out by the above writers, lies in the fact that it represents a persistent embryonic feature. The anterior abdominal vein of the adult frog originates by the fusion of a pair of larval veins carrying blood from the hind limb to the sinus venosus Posteriorly the fusion is complete, anteriorly the right vein usually disappears, the left loses its connexion with the sinus venosus, and a new connexion is acquired, namely, with the hepatic portal system The specimens A and B, therefore, show a loss of the right anterior portion of the ventral vein, have retained the connexion with the sinus venosus through the subclavian vein of the left side, but have not acquired the communication between the fused posterior veins (anterior abdominal) and the hepatic portal system In specimen C the *left* vein of the pair has disappeared, the communication with the sinus venosus remains, and the hepatic portal connexion has been acquired. Specimen A has been placed in the Museum of the Zoology Department of the College.

NELLIE B. EALES.

University College, Reading,
February 27.

The Life-History of Amœba.

SINCE the full details of some experiments on *Amœba proteus* carried out upon numerous strains of Amœba, each strain descended from one single individual, will not be forthcoming for some time, it seems advisable to make a preliminary announcement of the following results obtained by my assistant, Miss Isabelle P M'Guire.

On November 23, 1923, five glass dishes, ranging from 3 to 6 inches diameter, and height 3 inches, were provided with 50 c c of Glasgow tap-water, and 2 to 5 wheat grains, according to the capacity of the dish. These were left in a warm room over-night. On November 24 *one* adult amœba from Culture 11 (*Q J M S*, Vol. 69, Part I, Dec 1924), plus about 25 c c of the culture water plus some food organisms upon which *A proteus* feeds (these latter being carefully scrutinised and identified before being used), was inoculated into each of the prepared aquaria, care being taken to see that no minute amœbæ were included Each dish was then covered with a glass plate and put into a warm (temp. 60° F.) shady place. Tap-water was added gradually until each aquarium became full of liquid. One wheat grain was added to each on the following dates: March 23 and June 10. Two wheat grains were added to each on July 4 and September 9.

In February and March 1925 the aquaria were examined None of them contained adult amœbæ. In two of them, however, a population of small amœbæ were seen — recognisable under a ⅓-inch objective In two others encysted young amœbæ were visible amongst the debris. A few of these were transferred to a slide, and were kept in a damp chamber from March 12 last until March 16, on which date young amœbæ hatched out of the cysts. The fifth aquarium was a blank: no amœbæ or encysted young amœbæ were found.

Since Miss M'Guire is working in Notre Dame Laboratory, where cultures are constantly set up, it

was not deemed necessary to have control experiments other than those employed for the general culture work. It has been observed over and over again that an aquarium inoculated with food organisms only does not produce a population of *Amœba proteus*. In my prolonged work upon the life-history of *A. proteus* I have failed to find any evidence of the occurrence of syngamy in its life-history, and it is clear that the experiments now recorded greatly increase the probability that no such process occurs in the normal life-cycle of *Amœba proteus*

MONICA TAYLOR

Notre Dame,
Dowanhill, Glasgow

Total Intensity of Scattered X-radiation.

IN a report by Duane (Proc. Nat. Acad. Sci 10, 378, 1924) mention is made of the intensity of scattered radiation inside a closed box containing an X-ray tube. He states that "the amount of this box radiation that passes out through the slits into the spectrometer appears to be sufficient to dominate more or less completely the spectrum obtained." He then cites a number of instances where remarkably intense scattered radiation has been observed

We offer the following instance as additional evidence of the comparatively large intensity of the scattered radiation inside a closed room containing an X-ray tube

A Coolidge tube with a molybdenum target, which was operated at about 5 ma and 25 kv peak, was placed in a room about 22 × 25 feet and 10 feet high The tube was located about 2 feet from one side and equidistant from the ends of the room The height of the tube above the floor was about 4 feet We observed that a photographic film placed some 50 cm. from the tube and shielded from the direct rays by proper lead screens was almost completely blackened in three minutes We also found it possible to observe the scattered radiation at distances so great as two metres from the tube by means of a fluoroscope, the direct radiation being cut out by a sheet of lead placed directly in front of and in contact with the fluoroscope. This indicates that the intensity of the scattered radiation inside the room is nearly of the same order as that of the direct radiation However, in this experiment, as in the cases cited by Duane, the effect of the scattered radiation is integrated over a solid angle of 2π The solid angle in the case when the radiation proceeds through slits is much less than 2π, and so the intensity is probably not sufficient to modify the scattered spectrum as Duane suggests

O K DEFOE.
W. W. NIPPER.

Washington University,
Saint Louis, Missouri,
February 12.

The Auroral Green Line.

DR. SHRUM and I have found that the line $\lambda = 5577$, which we think is identical with the auroral green line, can be obtained with a mixture of oxygen and helium (with the latter greatly in excess), just as intense at room temperatures with a suitable pressure as when the discharge tube is surrounded with liquid air. Moreover, the results of our experiments strongly indicate that this spectral line has its origin in oxygen.

J. C MCLENNAN.

The Physical Laboratory,
University of Toronto,
April 4.

The Mortality of Plaice.

I KNOW of no facts in the natural history of male plaice which would render untenable the logically flawless hypothesis of Dr Bidder (NATURE, April 4), to the effect that it is what he calls "parental death" which occurs in this sex. In females the question of parental death is still in doubt unless "as the fish grows larger" (I quote Dr. Bidder) "k diminishes, and reaches 1 0 at a constant ratio of ovary-weight to body-weight which allows the residual body to recover after spawning" In this connexion I can only state that one occasionally encounters greatly emaciated very old females (called by fishermen "slinks") which have all the appearance of not being "long for this world." This observation, however, merely *suggests* that in the largest fish "ovary-weight *may* bear a lethal ratio to body-weight," the possibility of which is admitted by Dr Bidder

Perhaps I may now be permitted to suggest to Dr. Bidder one possible implication of his hypothesis as to the non-liability of the females to either parental or senile death. One consequence on an unfished area might be that the area would tend to become monopolised by a comparatively few females of immemorial antiquity, prodigious size, and devastating activity (since the larger the size the greater the activity necessary to procure food to maintain it) In these circumstances the adolescent females and mature males, necessarily restricted in their diet to the smaller molluscs, etc , would not stand a chance against the voracity of the giant "methuselahs" with their capacity for ingesting and digesting both large and small organisms I suggest that this competition *intra* species would prove fatal to its existence

WILLIAM WALLACE

Fisheries Laboratory,
Lowestoft,
April 7

Robert Browning as an Exponent of Research.

IN "Robert Browning as an Exponent of Research" (NATURE, February 28, p 298) why was it written ?

"As still to its asymptote speedeth the curve"

The curve itself is full of exponents, but is it asymptotic ? Is it continually *more slowly* approaching the right line ? I prefer to interline and excerpt rather than expect pure science of good poets.

Browning wrote

"But God has a few of us whom he whispers in the ear"

and

"He fixed thee 'mid this dance of plastic circumstance,
This Present, thou forsooth, wouldst fain arrest
Machinery just meant to give the soul its bent," etc.

and finally

"This man decided not to Live but Know.
Bury this man there ? . . .
Leave him—still loftier than the world suspects,
Living and dying."

W. R. WHITNEY.

Schenectady, N.Y., U.S.A ,
March 15.

Physiology and "Vital Force."

By Prof. FRASER HARRIS, M.D., D.Sc.

EFFORTS in the past to account for the mysterious powers and properties of living beings have in the main consisted of bringing in some supra-sensible, immaterial, ultra-cognisable "principle" or "entity" as the *causa causans*. This has been known under different names as time went on, but they have all referred to the same thing—psyche, pneuma, the anima sensitiva of Van Helmont, the life principle of Stahl, the Bildungstrieb of Blumenbach, the vita propria of Bordeu, the vitalis agens of Barthez, the Lebenskraft of Reil, the entelechy of Driesch, the elan vital of Bergson, and the biotic energy of Moore. It is of the essence of vitalism to explain life in terms of the less known, to account for the properties of a living being by the indwelling activity of an entity, agent, or force which, by its very metaphysical nature, is inaccessible to human investigation

To assert that each organ, tissue, and cell is as truly alive as is the whole organism is not "vitalism," but a correct physiological observation, for the isolated organ—heart or liver—can perform its vital functions long after separation from the body to which it belonged, and the cell taken from its tissue can live for years, as Ross Harrison and Carrel have proved, in its morphological isolation To say these organs have an independent life (whether it is said in English or in Latin *vita propria*), is to report an observation, to say that life is due to a "life force" or "entelechy" is to state a theory

If the vitalists had always been careful to admit that their view was only a theory of life, much acrimonious discussion would have been avoided; but when they declared that theirs was the only right view, their virtual claim to omniscience failed to arouse in many minds the enthusiasm expected These unconvinced people tried to explain life in terms of what they knew at least a little about—the non-living world around them, and they were in consequence called materialists and their theory mechanistic Now theirs is a theory no less than is the vitalistic The materialistic theory is that the observed known—the properties and behaviour of living organism—may be explained by applying to them our knowledge of the laws and properties appertaining to the non-living world It is an explanation of the known in terms of the more known rather than the less

The term "materialist" ought not to be used as one of reproach, the materialist is almost always a sincere searcher after truth, who, starting from his colleague the physicist's knowledge of the properties and behaviour of non-living matter, attempts to apply these to the behaviour of living matter He finds that many of the laws that hold good in the world of the non-living seem to be equally applicable to that of life In particular, he finds that vital heat, for example, is not in its essence different from heat of non-vital origin, that the great generalisation of the conservation of energy holds good for the mammalian body, that "vital" processes are accelerated by a rise, and retarded by a fall, in temperature exactly like "purely" chemical reactions in a test-tube. He is able to say in the language of his chemical colleagues that living matter (protoplasm) behaves in many respects like an irreversible colloidal emulsoid hydrosol.

The materialist found, as a matter of fact, that so many vital activities seemed to be the outcome of the operation of laws already proved true for the non-living universe, that he finally made so bold as to assert—and here he made the first mistake—that the mystery had vanished, and that protoplasm, chemically speaking, was only an excessively complicated form of matter. To this view Loeb committed himself. He wished us to believe that he had proved that the dividing line between the non-living and the living had been removed, and that we might pass by a number of gradations from physico-chemical simplicity at one end of the series to great physico-chemical complexity at the other. Somewhere on the way one passed from the non-living to the living.

Here the materialist went beyond what his premises allowed him, in this he was rash; but rashness inheres in the enthusiasm of youth, and biology is a very young science But the vitalist had always been rash for exactly the same reason; he had gone beyond experience. He had asserted that urea and sugar could never be made without the agency of life, because he had never found these substances anywhere except in living animal or vegetable tissues When, therefore, in 1828 Wohler made urea in a test-tube, and in the 'eighties of last century Fischer synthesised sugars, and when indigo was produced that had never seen a plant, and when the hormone adrenalin was constructed artificially, vitalism received a set-back, and materialism a corresponding encouragement. The anti-vitalistic view was further strengthened by the discovery that many ferments, solely the products of life, dealt with their "substrates" exactly like the inorganic catalysts so well known to chemists. Finally, when Loeb caused the unfertilised eggs of the sea-urchin, either by altering the density or composition of sea-water, to begin to undergo development, the days of vitalism seemed numbered

The materialist has, indeed, shown us how the plant is able to synthesise a carbohydrate from carbon dioxide and water through the stage of formaldehyde; but he himself is very far indeed from making a scrap of nucleated protoplasm, and until he does that, since we know no life apart from nuclei, it seems exceedingly improbable that he will be able to synthesise any kind of living substance. The materialist goes far beyond his observations when he maintains that the laws of the non-living world are the only laws which operate in the sphere of the living It is one thing for them to operate there, it is another for them to operate *alone*.

Life and living things are *sui generis*. It is better to admit at once that so far as our experience goes up to this hour, life is unique Prof. J. A. Thomson gives the following features of the uniqueness of living matter thus (Gifford Lectures, St. Andrews, 1915–16):

1. Its capacity for enregistering experience which, in the hereditary relation, is an expression of physiological inertia.

2. The self-maintaining tendency of the organism.

3. Its variability, or the capacity to give origin to the new.

Living matter can do what no non-living matter can—assimilate material wholly unlike itself; evolve from a minute and relatively homogeneous speck into an obvious and heterogeneous organism, reproduce its kind either by casting off buds or by gametes, pass through a life-cycle of irreversible stages, from infancy to youth, maturity, senescence, and death

So far as we can judge, the higher animals possess a variety of energy, nerve-energy, which also is *sui generis*. Finally, in the realm of the living we encounter those phenomena called subjective, the world of consciousness with all its modes—sensation, emotion, volition—a world which, so far as we know, never exists apart from living matter, and is absolutely unique

Certain critical vitalists sometimes blame physiologists for investigating living things by the methods of chemistry and physics The late Sir James Mackenzie wrote (*British Medical Journal*, March 1, 1924): "Physiologists place the organ in artificial conditions, employ artificial stimulation and obtain artificial results . such as the all-or-nothing law"

Now this criticism is rather hard to bear, because we have no methods or apparatus other than these "artificial" ones Although the biologist is investigating phenomena that are *sui generis*, he has unfortunately no apparatus which is adapted exclusively to biological use. The physiologist uses test-tubes, retorts, induction-coils, and galvanometers because there are no two kinds of instruments, one for biologists, and one for physicists. It is rather hard that, having been forced to use these things and having by so doing obtained results valuable to medicine, he should be stigmatised as a materialist

When we speak of the mechanism of gastric digestion, we merely use the expression as a conveniently short one for all those processes which are involved in the vital manufacture of pepsin and hydrochloric acid from neutral blood, their separation through and by the mucous membrane, and their solvent action upon food in the interior of the viscus. Nothing more "mechanical" is meant than this, and this is not mechanical at all. Only the last process, the solution of the protein, can go on *in vitro*; only life can manufacture pepsin from blood and an acid from alkaline or neutral salts, and separate these without digesting the wall of the stomach in the very act itself. It is most unfortunate that anything to do with a machine should be mentioned in this connexion.

Because the stomach "works" rhythmically and predictably we may call it a machine for turning out pepsin from blood and liken it to a machine for turning out (say) newspapers, but the secretion of pepsin is not mechanical, nor is the output of newspapers vital. Processes that closely resemble each other are not necessarily identical. In a decerebrated animal the same predictable reflex action can be obtained time after time from the same stimulus, and we may speak of the inevitableness of the mechanism of reflex arcs; but in no other sense is the spinal cord a machine.

Non-vitalistic physiologists are blamed not merely for speaking of organs and organisms as machines but also for daring to study organs and systems by themselves, whereby, it is alleged, they have lost sight of the wonderfully co-ordinated activities of the animal as a whole.

It would seem that the physiologists can never do anything right; at a time when nothing was known of the heart, or of the liver, or of the retina, what else could the investigator do than confine his attention to one thing at a time? Some of us, indeed, are trying to take a comprehensive synthetic outlook over the whole field of vitality, but that could not have been done by the pioneers, who could only push their way slowly into an unknown territory.

One would infer from the obituary notice of the late Sir James Mackenzie in the *Times* (January 27) that physiology is bankrupt Sir James is quoted as having said: "When this [his own view of physiology] is realised, the whole of the physiological interpretation of the functional activities of organs will have to be scrapped This is one of the results that I anticipate."

The physiological methods by which were discovered the localisation of cerebral function, reciprocal innervation, the endocrine function of the adrenals, the thyroid gland, and the pituitary, by which insulin was isolated and adrenalin synthesised, cannot be discredited

The experimental work of Schafer, Bayliss, Starling, Sherrington, Pavlov, MacLeod, and the Hills is not only not to be scrapped, but is also to be recognised as the logical modern basis of practical medicine The researches that led up to electrocardiography, with which Sir James Mackenzie himself was so conspicuously associated, are another illustration. From some of his expressions the incautious reader might suppose that current physiology was useless as an introduction to medicine, and that the secret of success in diagnosis and treatment consisted in the reinstating of a "vital force" Mackenzie, writing in the *British Medical Journal* (March 1, 1924), thus expressed himself "The reason for the lack of progress in respect of [knowledge of] living matter has been the absence of a knowledge of a vital force!" The whole tenor of this paper is that we must distrust the results of "artificial" stimulation of tissues because the effects of these are not normal, are not the same as those produced by the "vital force" The experimenter, in fact, comes under a heavy condemnation We are further told that because we do not better understand pain and why certain reflexes occur, this "vital force" must be postulated

The term "impulse" plays a large part in this neo-physiology. We are told "Where a cell discharges its energy in the shape of its peculiar [? particular] function, it at the same time discharges an impulse" We must know, therefore, where in the conceptual scheme of things, which has served physiology so well for the last thirty years, we can place this all-important "impulse."

As regards protoplasm three concepts are fundamental—(*a*) its affectability (irritability), (*b*) the stimulus that may operate upon it, and (*c*) its own response. The behaviour of a living efferent nerve may best illustrate the relations between the members of this biologic trinity. The neuroplasm, in virtue of its possessing the property of responding to a stimulus (affectability), and having received a stimulus, responds

by giving rise to an excited state which travels down the nerve as the impulse to the effector organ at the periphery, say a muscle, which twitches when the impulse impinges on it.

Let us suppose that the stimulus is a blow on the nerve, or a pinching of it, seeing that the electric stimulus of the induction coil was regarded so unfavourably by Mackenzie. Of course the existence of this impulse is an inference from what happens: a nerve receives a blow at one end and a muscle twitches at the other; something must have passed down the nerve, and that something we have for a long time called the impulse. It is said to travel down the nerve by reason of the nerve possessing conductivity.

The other indication that something is passing along the nerve is that if a galvanometer be substituted for the muscle, then when a blow is given to the nerve, the galvanometer records the presence, for a very short time, of an electric disturbance in the nerve. We infer that this electric current is an outward and visible sign of the existence of the invisible nerve-impulse. But just here a very important conclusion is reached, namely, that the impulse in the nerve on arriving at the muscle is for the muscle a stimulus to it to "contract", the impulse in the living nerve can, then, an instant later, be the stimulus for the living muscle, the response of which is a state of shortening or contraction.

We infer that in the intact animal the nerves are conveying impulses normal or homologous, exactly similar to our laboratory ones, because if a nerve *in situ*, for example the phrenic, is connected to a galvanometer, electric currents in this case also are seen to pass through that instrument. These natural (normal) impulses must be the natural (normal) stimuli for the muscles *in situ*.

All this is very elementary; but it is evidently necessary to restate it because it accounts for everything that Mackenzie observed without calling in the aid of a "vital force" at all. We fail completely to see where and why this force needs to be invoked, and why physiology is bankrupt if it is not so introduced.

If this "vital force" is another name for the nerve-impulse and it can scarcely be synonymous with either "stimulus" or "response"—then it is a superfluous term. If it is not a synonym for any of the three, then it is some fourth thing for which apparently there is no place in the scheme which has served biology so well in the past. The neo-physiologist may reply: it *is* a synonym for the nerve-impulse, but it comprehends "impulses" in all other tissues. Mackenzie's own words, in a paragraph headed, "The *impulse* a *vital force*," were "An impulse is the product of cell-activity, it can only be conveyed by living structures and acts by stimulating cells to discharge their function . . it differs from all other forces."

If the impulse in this passage be confined to *nerve*-impulse, no fault can be found with it, for the nerve-impulse is the product of (nerve) cell activity, it can be conveyed only by the living structures of the nerve, it acts by stimulating (muscle) cells to discharge their function (of shortening), and it differs from all other forces in that, as a nerve-impulse, it is *sui generis*. But why declare that unless we call this impulse a "vital force," physiology is to be discredited ("scrapped").

We do not need an additional name for the nerve-impulse; if we are forced to give it a new name, why give it one so redolent of obscurantist animism (*loc. cit.*)?

It is, however, quite clear that by "impulse" Mackenzie meant something that was active in all the tissues, for he speaks of *cells* in the widest sense. Now what are these impulses in tissues other than neural? What impulses are there in muscle, connective tissue, gland, fat, bone? In muscle we have states of contraction, and we can *call* them "impulses" if that will rescue physiology from the scrap-heap, but one fails to see what is gained thereby. As for "impulses" in connective tissue, fat, or bone, we have no evidence of them. In glands, doubtless, some states of excitation can travel (slowly) along, but again we see no benefit from calling them "impulses."

It is difficult to see, therefore, why physiology is to be declared as proceeding on a totally wrong road. It may be frankly admitted that there is in physiology more than is dreamed of by the mechanistic philosophy. The laws of matter that has never lived have failed so far to account for certain facts, for example, about absorption both from intestine and bladder, and for certain facts about urinary secretion. It has been shown that living membranes act very differently from dead ones.

The materialistic view of life has failed signally to account for certain realities of our experience of which consciousness is the group name. Huxley himself made his bow to consciousness and waved it away as an epi-phenomenon. For the materialist, consciousness cannot be a cause of neural activity; nor can states of body affect mind, for mind is an illusion. The mechanistic theories are incapable of throwing any light on the central fact of experience, the permanence of personality amid the flux of matter.

Prof. Haldane has well said that "living" and "mind" are not reducible to simpler terms; they are the axioms of biology, and this thinker firmly believes that physiology is being retarded by mechanistic conceptions which deprive us of a complete view of life. As Prof. J. A. Thomson has said [1] "We need new concepts such as that of the organism as a historic being which has traded with time" "We need these new concepts because there are new facts to describe, which we cannot analyse away into so-called simpler processes."

The most reasonable position to assume as regards vitalism is to insist that there is no compulsion for the biologist to be either a materialist or a vitalist. It is quite open to him to say that as he is dealing with an order of things that is unique, with existences that are *sui generis*, and that as his science is so young, he is not yet in a position to dogmatise and declare that *qua* life there are no categories beyond those the physicists and the chemists recognise.

Of all the many wise things Prof. Thomson said in his Gifford Lectures at St. Andrews (*loc. cit.* vol. 2, p. 147), this is surely one of the wisest: "We regard the question as one of the many *false dichotomies* with which man in his search for clearness has been led astray."

[1] "System of Animate Nature" (Williams and Norgate, vol. 2, p. 160).

The German Museum of Science and Technology.

THE new building of the Deutsches Museum at Munich is to be opened on May 7, which is the seventieth birthday of its founder, Dr. Oscar von Miller. A short account of this great museum will therefore be of general interest.

In NATURE of September 17, 1908, there appeared an account of the conception and foundation of the Museum, with a description of the collections then housed provisionally in the old National Museum building in Maximilian-strasse. Only five years before this, Dr. Oscar von Miller had laid his plan for a great national science museum before a small circle of men of science, technologists, and representatives of the German Government and of the city of Munich. The idea was taken up with enthusiasm, and very fine collections were quickly brought together and arranged in the above building, which was opened to the public on November 13, 1906. On the same day the foundation stone of the permanent new building was laid by the German Emperor, the Prince Regent, and Prince Ludwig of Bavaria. The site for this building had been granted by the city of Munich, and on October 20, 1906, the design of the architect Prof. Gabriel von Seidl had been selected from the thirty-one competitive designs which had been submitted. This site, an island in the river Isar, is shown in Fig. 1.

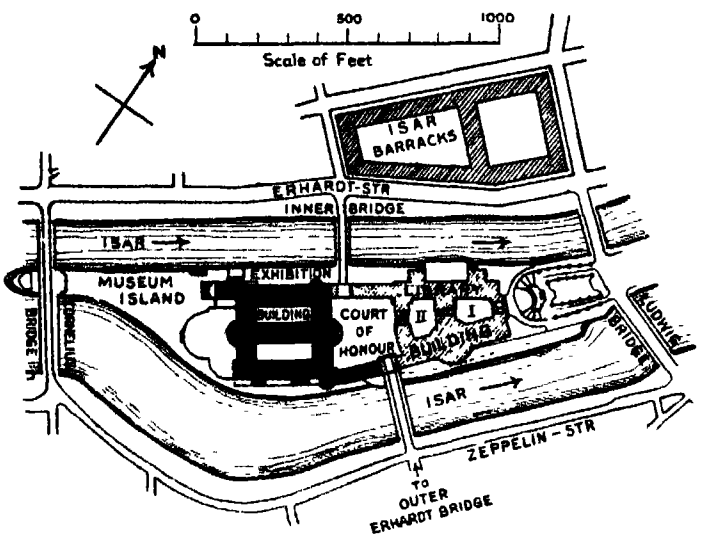


FIG. 1.—Sketch plan of the Deutsches Museum, Munich. The portion completed and occupied is blackened in. The old National Museum is less than half a mile to the north.

The rapid increase in the number of acquisitions to the collections soon made it necessary to seek accommodation additional to that provided by the old National Museum. For this purpose the rooms of the old dragoon barracks on the north-west bank of the Isar were utilised, and these were opened to the public on January 1, 1909.



FIG. 2.—The Deutsches Museum, Munich. The exhibition building completed, view looking south.

The new building, in accordance with the scheme laid down by the museum directorate, was planned in two main groups, as shown in Fig. 1, namely, the Exhibition building, and the Library building. The former was to house the unique exhibits already acquired, and to be on a scale sufficiently large to allow for ample expansion and development of the collections. The latter was to contain the collections of early and modern scientific and technical books, manuscripts, drawings, etc., as well as to provide workshops, laboratories, lecture-rooms, conference halls, etc.

By the summer of 1914 the skeleton of the exhibition portion of the museum building had been completed, and it was then anticipated that the building would be open to the public by 1916. Building operations, however, were protracted by the War, but in spite of many difficulties, progress, though slow, has since been maintained steadily, and this portion of the Museum (shown in Fig. 2) is now ready to be opened. In September 1914, the old Isar barracks being required for war purposes, the collections therein had to be stored away. By September 1922 certain of the rooms in the old National Museum were closed, and the work of transferring the collections to the new building was commenced. On September 18, 1923, the whole of the old building was closed to allow of the systematic transference of the rest of the collections.

The characteristics and attractiveness of the collections, even when housed in their temporary buildings, were referred to in NATURE in 1908. These features rested not only in the valuable exhibits themselves, but in the unique method of presentation, which aimed at giving the whole nation, student and layman alike, but particularly the young, an insight into and review of scientific and technical conceptions and inventions, with the human aspect carefully interwoven. The provision of this magnificent new Museum has allowed these

features to be developed in an enhanced degree, and the result is one of which the German nation may well feel proud.

With regard to the library building, the construction of which has still to be carried out, the original design of Prof. G von Seidl was at an early stage found to be quite inadequate. The number of bequests and promises of books, drawings, plans, films, phonograms, etc, so exceeded original expectations that proper accommodation could be met only by a complete modification of the building programme New plans were accordingly prepared by Prof Emanuel von Seidl, who took over the work on the death of his brother As indicated in the plan (Fig. 1), two long wings follow the lie of the land towards the north-east, where they are connected by a frontage facing a monumental approach leading from the Ludwig bridge. These wings are further connected with each other by two transverse buildings. From the approach court a passage leads to Court I., another to Court II., and a third leads to a large impressive Court of Honour, on the opposite side of which is the chief entrance to the exhibition building. This Court is also directly accessible from both sides of the river by means of the Erhardt bridges. The library building will be provided with four floors above the ground-floor and basement, except in the two low wings by which it is connected to the exhibition building.

Amongst the many objects specially designed or acquired for the new building are the two giant planetaria, one of which was described in NATURE of December 27, 1924

Obituary.

DR CARL ULRICH.

BY the death of Dr Carl Ulrich on February 9, Austria has lost one of its foremost chemists, and radio-chemistry one of its pioneers

After completing his course at the University, Dr. Ulrich was appointed assistant to Hofrat Lieben in the Chemical Institute of the University of Vienna. Later, he took up a post in the Auer works at Atzgersdorf, where, in conjunction with Dr Haitinger, he made a study of the working up of pitchblende on a large scale He was largely responsible for the organisation and equipment of the radium works at Joachimstal in Bohemia, the management of which he took over in 1910 Here he laboured until the close of the War, when the radium works passed into the hands of the Czecho-Slovakian Government, and Dr. Ulrich, being of Austro-German nationality, had to resign his post. During the next few years he acted as adviser to the Ministry of Trade in Vienna, but was pensioned off two years ago Since 1918 he had been engaged on radio-active work in the Vienna Radium Institute.

Dr. Ulrich always showed a keen and active interest in the work of the Radium Institute, and he was ever ready to give it the benefit of his ripe experience in the varied chemical problems that arose from time to time Many of the tertiary radium standards to be found in various parts of the world are primarily the work of his hands, and they provide an appropriate memorial to his labours He died of sarcoma of the lungs, which, in the opinion of his medical advisers, was a direct result of his long-continued manipulation of large quantities of radium It is a significant fact, however, that Dr Ulrich had not worked with radium in quantity since he left Joachimsthal in 1918

Dr Ulrich was keenly interested in the development of the science of isotopy, and some of the earliest work on the isotopes of lead and thorium was performed with material supplied or rendered accessible by his intervention To the world of science in general, and to his Austrian colleagues and friends in particular, the death of Dr Ulrich means a great loss.

ROBERT W. LAWSON.

THE death occurred on December 19 last of Prof. H L Wells, and we are indebted to the *American Journal of Science* for the following details of his life and scientific career Horace Lemuel Wells was born on October 5, 1855, in New Britain, Connecticut, and went to Yale University in 1884 as instructor in analytical chemistry in the Sheffield Scientific School, and eventually was appointed professor of analytical chemistry and metallurgy. This post he held from 1893 until 1923, when he was made professor emeritus Prof. Wells devoted much attention to the analysis of minerals; he determined the composition of a number of minerals from Branchville, described with E S Dana the new mineral beryllonite, and analysed a new platinum mineral which he called sperrylite In 1891 he obtained a supply of the rare mineral pollucite from which a quantity of cæsium salts, hitherto only known in small quantities, was extracted. This furnished material for a series of investigations on cæsium compounds which covered more than thirty years. About one-half of his published work relates to these substances Beginning with the perhalides of cæsium, he investigated systematically the double salts of this element, and later discovered a series of triple salts, notably triple thiocyanates. In 1897 Prof. Wells translated Fresenius's "Qualitative Analysis," and he also published works on chemical calculations. In 1904 he became an associate-editor of the *American Journal of Science* He was elected a member of the National Academy of Sciences in 1903.

WE regret to announce the following deaths:

Mr S. R O Dudfield, hon. foreign secretary, Royal Statistical Society, past president of the Harveian Society, London, and for thirty years medical officer of health for Paddington, on April 19, aged sixty-four.

Sir Rickman John Godlee, Bart., K.C.V O., hon. surgeon in ordinary to the King and a past president of the Royal College of Surgeons, on April 20, aged seventy six

Sir David Lionel Goldsmid-Stern-Salomons, Bart., vice-president and treasurer for many years of the Institution of Electrical Engineers, on April 19, aged seventy-three.

Current Topics and Events.

SAMUEL F. B. MORSE, of Charlestown, Massachusetts, inventor of the Morse electro-magnetic recording telegraph, was born on April 27, 1791 He died a little more than half a century ago That Faraday was born also in the same year is an interesting coincidence The latter, lecturing at the Royal Institution in 1858, said . "Thoughts of an electric telegraph came over the minds of those who had been instructed in the nature of electricity, as soon as the conduction of that power through metals was known" Prof Morse himself declared that he had "a distinct recollection of the manner, the place, and moment when the thought of making an electric wire the means of communicating intelligence came into my mind and was uttered" He was referring to the year 1832, and specially recalling an experience when a passenger on the *Sully*, a boat plying between Havre and New York The construction and practicability of apparatus for the purpose in view occupied many anxious years Morse held that such an invention would mark an era in human civilisation and contribute to the happiness of millions For long he worked in penury At last, in March 1843, Congress voted 30,000 dollars for definite experimental projects in connexion with the invention In May, the following year, success in actual service was achieved The message, "What hath God wrought," was sent from the Capitol at Washington to Baltimore, Morse operating the transmitter It is of interest to add that at the Oxford meeting of the British Association in 1847, Sir Robert Inglis, the president, referred to the rapid progress of telegraphy in the United States as the immediate outcome of Morse's work, and alluded with regret to the circumstance that in England this great discovery had been, so far, inadequately adopted

DR. HENRY FAIRFIELD OSBORN has issued his presidential summary of the work of the American Museum of Natural History during 1924 in advance of the main report He entitles it "The American Museum and Education," and contrasts the education by means of this (or any properly organised) museum with that of the school and the university comparing it with that direct teaching through Nature which was the privilege of boys and girls in the Stone Age That severe but inspiring approach to the duties and pleasures of life has been smothered under cities, lectures, books, and newspapers Museum teaching should aim at restoring that immediate vision, and should regard "books and learning as the handmaids and not the masters of education." Dr Osborn passes on to acknowledge the help received by the American Museum. Although a private institution, the museum manages to secure every possible aid from the United States government in its foreign relations. Consequently its expeditions meet with the cordial assistance of viceroys, governors, ministers, and government officials in the numerous foreign countries explored. Foreign sportsmen also, realising the value of the museum's work, readily place their skill and experience at its disposal. We are far from grudging the help that is here so cordially acknowledged, but we should like to see more of the same assistance given by British governments to British expeditions

GOVERNMENTS, no doubt, help those that help themselves This it is that has been the merit of the American Museum of Natural History Beginning with endowments and financial assistance from a few rich men, it now rests largely on the usual subscriptions of 7952 regular members The average annual contribution from the City of New York amounts to little more than one-third of the whole Would it not be possible for the Natural History Museum at South Kensington to obtain similar support? The National Art Collections Fund proves that even government institutions need, and can receive, private help. We in Great Britain need not be ashamed to follow the example of the American Museum of Natural History

ON Friday, April 18, Dr Fournier d'Albe gave a private demonstration of his television apparatus at his laboratory at Kingston-on-Thames The apparatus shown represented a further stage in the simultaneous transmission of several elements of a picture by allocating different audio-frequencies to different elements An image of the object to be transmitted was projected on a revolving siren disc provided with thirty concentric circles of holes. An image of the disc was, in turn, projected on a transmitting screen studded with thirty small selenium tablets, arranged so that each tablet was exposed to a different audio-frequency of intermittent light produced by the disc The selenium tablets were connected in parallel with a two-valve amplifier, and the sound produced in a loud speaker at the receiving station was allowed to act upon thirty compound resonators, each of which responded to its own note when it occurred in the medley of sound transmitted The response manifested itself by the appearance of a luminous patch on a ground-glass screen, reproducing an element of the original object both as to position and intensity As the response occurs within a twentieth of a second, it is claimed that the apparatus transmits some six hundred signals per second As, however, the complete transmission of an object such as a changing face requires at least ten thousand signals per second, there is still a considerable gap to be filled Dr. Fournier d'Albe hopes to do this by increasing the number of resonators and their selectivity, or, in the last resort, by transmitting over more than one wire or on more than one radio-wave-length.

EXCAVATIONS at Ur during the final month of the season have brought to light a remarkable stele which Mr. C L. Woolley, writing in the *Times* of April 15 and 16, regards as the most important monument yet found on the site As an example of Sumerian art, it ranks with the famous Stele of the Vultures now in the Louvre. The reliefs on this stele among other subjects show Ur-Engur, the

founder of the Third Dynasty and the builder of the ziggurat, actually engaged in its construction Two series of clay tablets have been found, one dating from 2200 B C , the other from 2000 B C , which give an intimate picture of the economic organisation of the temple with its establishment of ministers and court officials, additional to the priests, each in charge of a department—war, justice, lands, the household, the harem, etc. The tablets show in detail the receipts from tithes and rents or shares in the produce of the lands, while monthly balance sheets give the amounts received in kind from each farmer as well as the townsman, the latter paying in hides, gold, silver, copper, and other commodities A strict account of the outgoings shows the rations issued to each of the numerous inmates of the temple and its precincts These included a large number of women devotees who worked in factories, chiefly at weaving The amount of wool thread issued to these and to the piece-workers, who occupied workshops outside the walls, is recorded with the quantity and quality of material it produced in each case The food paid as wages was proportionate to work done, and children and old women received less than the young women Temple officials when travelling held letters of credit which enabled them to obtain food in the cities through which they passed

THE first of the series of lectures on "Illuminating Engineering," arranged under the auspices of the Illuminating Engineering Society at the Polytechnic, was given on Monday, April 20, when Mr J W T Walsh of the National Physical Laboratory delivered an address on "The Nature of Light and its Measurement" After a short introductory sketch of the development of the illuminating engineering movement, Mr Walsh explained the chief terms used in dealing with illumination, processes in the photometric laboratory, and the use of portable illumination photometers, several examples of which were exhibited and examined after the lecture. There was a representative audience, including members of the staff of firms in the lighting industry and several of the lecturers responsible for subsequent items in the course The organisation of a course of this nature, reviewing progress in various aspects of illumination, is a good idea which might be taken up by other educational institutions. It is particularly desirable that representatives of firms commercially concerned with illumination should have opportunities of hearing an impartial and scientific review of the problems with which they are concerned and of obtaining the latest information from specialists on various aspects of the subject

IN a lecture delivered before the Royal Institute of British Architects on April 20, Mr P J Waldram discussed the natural and artificial lighting of buildings. Mr. Waldram reviewed problems involved in determining access of daylight into buildings, on which he is an expert, but artificial lighting was not dealt with in detail The paper, however, dealt with several suggestive points, especially in connexion with comparisons between natural and artificial light. Mr. Waldram apparently thinks that a considerably higher illumination is necessary for most processes in the case of artificial light than is necessary by daylight, but this view was disputed by several speakers in the course of the discussion. This seems to be a question on which further study is needed, and it is somewhat surprising that such a fundamental point should still be a matter of doubt In view of the effect on the eye of an overhead sky of considerable brightness, and the presence of adjacent objects in general far brighter than those usually encountered by artificial light, one has the impression that the eye is accustomed to a range of illuminations by daylight much in excess of that afforded by artificial means

IN his presidential address to the Ipswich and District Natural History Society, Mr J Reid Moir, as reported in the *East Anglian Times* of April 2, surveyed the archæology of Ipswich from Pliocene to Anglo-Saxon times. The evidence of the fossils of the Red Crag, indicating a gradual lowering of the temperature, together with the occurrence of striated flints and far travelled rocks in the underlying detritus bed, suggests that the crag was laid down in the first glacial period of East Anglia The Cromer Forest Bed of Norfolk is not represented at Ipswich, but a series of gravels rest upon the Red Crag in which are implements, of Early Chellean Age in most cases, evidently derived from some older deposit It is possible that this deposit was of Cromer Forest Bed age The Tills and Contorted Drift of Norfolk overlying the Cromer Forest Bed are probably represented at Ipswich by the Kimmeridge Boulder Clay belonging to the second glacial period of East Anglia The receding ice left hollows, often of considerable depth, such as the Foxhall Road Site, which contain in the brick earth and gravel filling hand axes of Acheulean and Mousterian types The glacial deposits overlying the brick earths represented the third glacial epoch of East Anglia The Upper Chelky Boulder Clay contains Mousterian implements torn from the brick earths by the ice In a following period of climatic improvement, Upper Mousterian man inhabited the area, followed by Aurignacian man, whose occupation level was on the surface of a layer of stoneless loamy sand This period was sealed in by a deposit of hill-wash, the result of a lowering of temperature, in which Solutrean implements had been found

FOR several years past a Synonym Committee, working at first in connexion with the Ministry of Agriculture and later with the National Institute of Agricultural Botany at Cambridge, has been endeavouring to reduce the confusion which exists in respect of the names of potato varieties and their synonyms. The results of the investigations have been embodied in a pamphlet which includes information concerning varieties that have been definitely tested in regard to their susceptibility to wart disease. Most of the tests for immunity were carried out at Ormskirk, but some were conducted by the Scottish Board of Agriculture. Two years' freedom from wart is officially required to establish immunity, and the

list includes as immune only such varieties as have been unaffected by wart disease in at least two seasons' tests, though a single test is sufficient to brand a susceptible variety. Two lists are given, one of distinct varieties, in which case the immunity or otherwise is recorded, the other of synonyms, in which reference is made to the distinct variety of which the synonym is but another name. While acknowledging assistance received in the compilation of the lists, the Synonym Committee accepts full responsibility for the publication and for the inclusion or otherwise of any given name.

REFERRING to our note (NATURE, April 11, p 545) on Prof. R. Hamer's suggestion to name the undiscovered element of atomic number 43 "moseleyum," after H. G J. Moseley, Prof Irvine Masson writes that such action would not, as stated, be an innovation, as "one element *is* named after an individual namely, Gadolinium, a rare-earth element, called after Gadolin" The historical facts appear to be as follows. The mineral gadolinite, discovered in 1788, was named after the Finnish chemist Johann Gadolin, who in 1794 discovered a new earth—yttria—in it About a century later, Marignac showed that yttria (which he had obtained from samarskite) contained a new element, and when Lecoq de Boisbaudran announced to the Paris Academy of Sciences that Marignac had chosen for it the name "gadolinium," he gave no reason for the selection (*Comptes rendus*, 1886, p 902). The case of the element samarium is somewhat similar The complex parent mineral samarskite was, apparently, named after a Russian mine officer, Samarski When the existence of the element was proved, Lecoq de Boisbaudran told the Academy that the honour of its discovery really belonged to several investigators, and he proposed the name "samarium" because the word was "derivé de la racine qui a déjà servi à former le mot 'samarskite'" (*Comptes rendus*, 1879, p. 214) Whether the words "gadolinium" and "samarium" were derived directly, or indirectly, from the names of men or minerals appears of little moment, both perpetuate the names of individuals, and therefore, in this sense, the appellation "moseleyum" would have two precedents.

A MEMORANDUM, addressed to the Council of the Industrial Institute, 102 Belgrave Road, London, S.W.1, has been issued suggesting an inquiry into "Balanced Industrial Development" The objects outlined include the promotion of scientific research and its organised application to industry, the strengthening of the foundation of industrial ethics, the formation of a clearing house for the collection and diffusion of information on all questions of industrial relations, and the examination of legislative and other proposals affecting industrial relations The recently formed Industrial Institute is essentially non-political and it receives influential support from eminent representatives of both labour and capital, scientific and industrial bodies. It is hoped that the co-operation it affords will promote not only a better recognition of the value of science to industry, but the viewing of controversial questions in a more impartial and scientific spirit. The memorandum suggests the appointment of a special committee of the Institute to investigate all such problems

THE eighth of the public lectures on "Physics in Industry" being delivered under the auspices of the Institute of Physics will deal with "Physics in the Rubber Industry with special Reference to Tyre Manufacture" The lecture will be given by Dr. W Makower in the rooms of the Royal Society, Burlington House, London, on Wednesday, April 29, at 5 30 P M

THE summer meeting of the Institution of Electrical Engineers will be held this year at Birmingham on June 9-12. As three hundred members and their ladies have already sent in their names, others wishing to take part are advised to send their applications without delay to the Secretary of the Institution, Savoy Place, Victoria Embankment, London, W.C 2

THE Council of the Royal Statistical Society will, in 1925, again award the Frances Wood Memorial Prize value 30*l*. The prize will, as before, be awarded for the best investigation received not later than October 26, of any problem dealing with the economic or social conditions of the wage-earning classes, the subject to be treated on statistical lines Particulars can be obtained from the honorary secretaries of the Royal Statistical Society, 9 Adelphi Terrace, W C 2

THE Coopers Hill War Memorial Prize, founded by members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the War, is awarded annually by the Institution of Civil Engineers and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford The triennial award will be made this year by the Council of the Institution of Electrical Engineers for a paper on "The Applications of Electricity to Metalliferous Mining" Papers should reach the Secretary of the Institution not later than October 31

A BILL has recently been passed by Congress, by which the United States Coast and Geodetic Survey is "authorised to make investigations and reports in seismology, including such investigations as have been heretofore performed by the Weather Bureau" In at first placing such work under the Bureau, the United States Government followed the example of other countries, for example, of Italy, where, since 1887, the system of earthquake stations has been under the control of the Central Meteorological Office The advantage of the change in the United States is obvious, for the Coast and Geodetic Survey may at any time, as in 1906, be called on to measure the crustal deformations in the central district of a great earthquake

THE highly successful conference held at Hoddesdon in September 1924, on Special Libraries and Information Bureaux, has resulted in financial support being obtained from the Carnegie United Kingdom Trustees for a period of two years in order to give the new movement an opportunity of becoming self-supporting.

Mr. G. W. Keeling has been appointed organising secretary to the committee which was formed during the conference to ensure the continued co-operation of the interests there represented Active arrangements are being made for the holding of a second week-end conference at the end of September of this year, and for the preparation of a directory of special libraries and information bureaux for the United Kingdom

THE gold medal of the Institution of Mining and Metallurgy has been awarded to Dr Richard Pearce in recognition of his lifelong services in the advancement of metallurgical science and practice Dr Pearce was for many years engaged in metallurgical work in the United States, and since his return to England has been associated with the tin-smelting industry The Council of the Institution has awarded "The Consolidated Gold Fields of South Africa" premium of forty guineas to Mr Thomas Pryor, for his paper on "The Underground Geology of the Kolar Gold Field," and the "Arthur C Claudet" and "William Frecheville" students prizes of ten guineas each to Mr F H Edwards (Birmingham) and Mr D W Bishopp, respectively

THE National Academy of Sciences having approved the recommendation of the Committee on Award of the Daniel Giraud Elliot Medal for 1924, the medal and honorarium will be presented at the April meeting of the Academy to Abbé Henri Breuil for his work, in collaboration with MM. Capitan and Peyrony, on the volume "Les Combarelles des Eyzies," as the most outstanding contribution of 1924 in this field. Henri Breuil is the foremost living authority on the archæology of the Old Stone Age His chief contributions are the recognition of the great Aurignacian upper palæolithic stage and the monographing of the entire Stone Age art of France and Spain He is a man of untiring endeavour, great personal courage, and deliberate and philosophic interpretative powers. He is the head of the Institut de Paléontologie Humaine, which was founded by the late Prince of Monaco This is the eighth award of the Daniel Giraud Elliot Medal

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: junior assistants at the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (May 9), Superintendent of a Government Research Establishment in Lancashire—"S U," c/o Chas. Barker and Sons, Ltd, 31 Budge Row, E C 4, a junior lecturer in science at the Royal Military Academy, Woolwich—The Under-Secretary of State, the War Office (S D 3), Whitehall, S W 1 (May 30).

Our Astronomical Column.

THE BRILLIANT FIRLBALL OF EASTER SUNDAY.—Mr W F Denning writes On the evening of Easter Sunday, April 12, at 21h 40m G M T, a fireball of large size and dazzling brilliancy was seen by hundreds of observers in the south-west of England A great number of descriptions have been received from spectators in Cornwall, Devon, Somerset, Pembroke, Glamorgan, and other places According to most of the estimates, the fireball moved rather slowly and passed over the sea between Cornwall and Pembroke It concluded its path when about twenty-five miles west-north-west of Strumble Head, near Fishguard The fireball may have fallen into the sea when it had traversed another twenty-five miles, but it is doubtful if it survived, and no reports have come in that it was actually seen to fall

The object was one of the most brilliant that has appeared in recent years The illumination of the atmosphere and landscape which it occasioned just before its disappearance was remarkably vivid and startled many observers Two or three minutes afterwards a deafening noise, like a double explosion, was heard at Fishguard, and at other places in the neighbourhood

The nucleus of the fireball is described as emitting a steel-blue colour, and it left a broad train of fiery sparks in its wake, but this vanished immediately. During its visible course the object descended from about sixty-nine to twenty-two miles at a very moderate speed, and was directed from a radiant point in Virgo, but the exact position of this is not defined by the observations available at the present time

COMETS.—The three comets (Schain, Reid, and Orkisz) have all been observed recently in England. The two latter are fairly bright, about magnitude seven, but Reid's is getting too low for easy observation here

Mr Orkisz discovered his comet at the small observatory on the summit of Mt Lusina in Poland, a few miles south of Krakow It is rapidly moving north and will soon become circumpolar

Mr G Merton (B A A circular No 5) has computed the following orbit from a combination of ten observations extending from April 5 to 14:

T	1925 April 1·2904 G M T	(new)
ω	35° 55′ 17 3″	1925·0
Ω	318 1 25 3	
i	99 57 22·6	
log q	0 045126	

EPHEMERIS FOR 0h G M T

	R A	N Decl	log r	log Δ.
Apr 25	22h 51m 35s	40° 13′	0·070	0·180
May 3	23 7 31	51 5	0·087	0·170
,, 11	23 31 53	62 2	0·108	0·172
,, 19	0 17 14	72 17	0·130	0·185

In May the comet will be observable throughout the night

Schain's comet is still a difficult object, of about magnitude eleven It is receding from the earth, and this more than offsets its slight approach to the sun. Perihelion passage will probably be about August, and the perihelion distance promises to exceed that of any known comet, being apparently somewhat greater than that of the comet of 1729 (4·05 astronomical units) which has held the record until now. The orbit was an extremely difficult one to compute from the early observations, and the dates found for perihelion passage ranged from November 1924 to February 1926

The following approximate ephemeris should suffice for finding the comet:

	R.A	N Decl.
Apr. 28	10h 50m	4° 3′
May 6	10 41	4 17
,, 14	10 32	4 27

Research Items.

RACIAL PSYCHOLOGY IN THE UNITED STATES.—The population problem and, in particular, the colour question in the United States, which has produced much dogmatic but unsubstantiated assertion, has had a beneficial effect in leading to an examination of records for exact data which may bear upon the question of mental racial differences. In the *Scientific Monthly* for March, Dr. Bertha M Luckey of Cleveland, Ohio, a city which contains a large percentage of foreign-born adults, has analysed the results of tests of school children for intelligence As the data were obtained from the clinic, the majority of the children were super- or subnormal Figures are shown for ten nationalities The highest percentage of subnormal children is shown by the Negro and Polish groups (65 per cent), and the lowest by the Jewish (29 per cent), the intermediate order being Slavish, Slovenian, Italian, Hungarian, German, Bohemian, and American (30 per cent). The largest percentage of bright or unusually bright occurred among the Jewish (24 per cent), the remaining groups being in the following order American, German, Bohemian, Slovenian, Hungarian, Slavish, then Polish, and Negro, each 1 per cent, and Italian, 0·5 per cent Yet in the class "imbecile" the Jewish and American groups had more than the Negro and Slovenian groups Another paper in the same issue, by the Rev J E Gregg, compares the academic results of students admitted to the Hamilton Institute over a number of years, beginning in 1901 Seven grades of colour, ranging from black to "no trace of colour," have been recorded, but the scholastic results show little difference between the colour groups Of the twenty-one best scholars of the graduating classes in eleven years (1914–24), the percentages are as follows Dark brown, 28·5, brown, 28·5, light brown, 28 5, light, 14·2 Of the entrants in 1901–10, the three groups dark brown, brown, and light brown formed 82 3 per cent

THE COUSIN IN VEDIC RITUAL.—In the *Indian Antiquary* for January, Mr A M Hocart has an interesting suggestion to offer as to the interpretation of the word *Bhratrvya*, which occurs in a formula indicating that the Vedic sacrifice was a victory over evil powers opposed to the sacrificer The formula is translated "slaying his wicked spiteful enemy." The word *Bhratrvya*, "enemy," is doubtful, but appears to indicate relationship, possibly "cousin" It is suggested that it may bear the meaning more specifically of mother's brother's son, *i.e.* cross cousin. It would then be a case of the ceremonial hostility of cross cousins. There is no direct evidence which supports the suggested meaning of the word, but it is possible that the Vedic relationship system was classificatory and would therefore as elsewhere give rise to cross-cousin hostility Further, from both Fiji and South Africa there is evidence that the cross cousin in the cases of ceremonial hostility is a representative of the gods. The hostility is not real or infused with hatred. The cross cousin may be identified with the demons through some conception such as is indicated in the story that Namuci, the demon, stole Indra's vigour, the essence of his food The cross cousin may therefore eat the sacrifice, or part of it, taking upon himself the evil and acting as scape-goat; as such he is reviled and despised, and in Fiji and South Africa, driven away.

POLYEMBRYONY IN PLATYGASTER.—The remarkable phenomenon of polyembryony is now known to be a constant feature in the development of certain minute species of parasitic Hymenoptera In the *Journal of Agricultural Research*, vol 28, No 8, 1924, Messrs R W. Leiby and C. C. Hill describe the polyembryonic development of *Platygaster vernalis* in the larva of the Hessian fly The egg of the Platygaster is so placed in the egg of the Hessian fly that it is eventually found in the mid-intestine of the host embryo or young larva, with unfailing regularity Each egg of the parasite gives rise to about eight embryos, all of which it is believed are of the same sex In the course of maturation two polar bodies are formed, which become the original paranuclear masses, while the cleavage nucleus becomes the progenitor of the embryos. The latter are surrounded by a membrane, or trophamnion, which is formed from the paranuclear masses, and when the larvæ are ready to issue, they rupture the trophamnion, thus becoming liberated into the host's intestine The larvæ eventually consume the whole of the contents of the Hessian fly larva, leaving only the cuticula Each parasite constructs a cocoon within which it transforms into a pupa and later into an imago Although the parasites which issue from one host are usually of the same sex, it is believed that the occasional mixed broods that are met with originate from a fertilised and an unfertilised egg deposited in the same individual egg of the host

PLEISTOCENE FOSSILS FROM SAN PEDRO, CALIFORNIA.—From a cutting through Nob Hill, at San Pedro, California, exposing beds of the Lower San Pedro Series of the Pleistocene, Mr T S Oldroyd obtained from the deposit some 242 species of Mollusca (Proc U S Nat Mus, 65, art 22) At the close of this period when the climate of California began to get warmer, the majority of these molluscs migrated north, some 115 being found to-day in Puget Sound, or they sought the cold waters of a greater depth, for there seems to be a trail of the northern molluscs in about 100 fath all along the coast as far as Lower California, whilst a few accustomed themselves to the change and are found living now near San Pedro With the exception of two land and two freshwater snails, doubtless washed down into the deposit, the mollusca are all marine, and the author is able to append to his list the descriptions and figures of 20 new species and two new subspecies, mostly small forms Some crab remains were identified by Miss Rathbun, and the list of these and a few other invertebrates is included in the paper.

ICE IN THE ARCTIC SEAS IN 1924.—The annual report of the Danish Meteorological Institute (Isforholdene i de Arktiske Have, 1924) is fuller than usual, especially as regards the Kara and Barents Seas and the east coast of Greenland, but, owing to lack of information, is very meagre concerning the Beaufort Sea and coasts of eastern Siberia In European Arctic regions the year on the whole was marked by less ice than is the rule during spring and summer. In August and September the Kara Sea was exceptionally free from ice The White Sea was clear in June and in the autumn froze much later than usual. In the north-eastern part of the Barents Sea there was more open water than usual, in August, the only month for which there are data, it came very near to Franz Josef Land During April and May very heavy pack extended to the south-west of Spitsbergen so far south as Bear Island, but the northern part of the west coast, as usual, was clear. In June conditions changed completely, resulting in a summer with exceptionally little ice

in Spitsbergen waters A Norwegian sloop circumnavigated North-East Land during August On the east coast of Greenland the few observations suggest a narrower belt of close pack-ice than usual Iceland was touched by pack-ice only during February The Newfoundland Banks had little ice and few icebergs, and Davis Strait was fairly clear The report is illustrated with several maps

ISOSTASY AND GEOLOGY.—A valuable paper on "The Geological Implications of the Doctrine of Isostasy," by A C Lawson, appears as Bulletin No. 46 of the National Research Council (Washington, June 1924) It is pointed out that in considering the transfer of matter from one portion of the earth's surface to another, it is often necessary to recognise that the newly loaded area may be widely separated from the source of the load In such a case the loaded region and the surrounding territory cannot be balanced with the rest of the earth's crust by merely local flow, a general plastic deformation of the geoid then appears to be necessary to establish isostatic equilibrium Continental glaciers, epicontinental seas, and large deltas are discussed as examples in which local deep-seated compensation fails to restore a world-wide balance In the case of plateau lavas, it is not clear to what extent there is a real transfer in the horizontal as opposed to the vertical sense Mountain ranges are considered both with and without a downward protuberance, and the discussion clearly supports the view that ranges are supported by flotation due to a downward concentration of lighter rock immersed in heavier rock It is suggested that oceanic deeps may be due to a stretching and thinning of the lighter upper part of the crust accompanied by an upward sag of the heavier sub-crustal matter The process recalls the mechanism of Wegener's displacement hypothesis, and like it involves great tensional stresses due to the flowing of the crust down a low gradient As Lambert and Jeffreys have independently shown, no adequate cause for such a process can be imagined in harmony with our observational knowledge of the strength of known rocks

NATURAL GAS IN ALBERTA.—The Canadian natural gas industry is second only to that of the United States, the annual production in the former country amounting to some 20,000,000,000 cubic feet, valued at five million dollars The bulk of this gas comes from the provinces of Alberta and Ontario, but there are already signs of exhaustion in the eastern fields, and steps are being taken to conserve the remaining resources and to regulate the supply In Alberta the position is different, since several large flows have recently been struck, and there are also many potentially favourable areas which have not been explored Much of the Alberta natural gas is apparently a dry gas, so that gasoline extraction has not on the whole assumed the importance in the Canadian gas industry that it has done in the United States, one area, however, that of Turner Valley, yields a wet gas capable of giving from 0·2 to 0·7 gallons of gasoline per 1000 cubic feet of gas, which compares favourably with some of the results achieved in the Mid-Continent region of America, the gasoline-yielding gas shows on analysis, as might be expected, a much higher proportion of ethane than the dry gas, with a corresponding decrease in the nitrogen content, a point of importance in connexion with helium recovery It seems unthinkable that helium should be allowed to go to waste in view of its enormous value for aircraft purposes, but such is largely the case in Canada at the present time. Mr. R. T. Elworthy, in his report on the "Natural Gas in Alberta" (Canada, Department of Mines, 1924 for 1923), states that from two fields, Bow Island and Foremost, some ten to fifteen million cubic feet of helium per year might be obtained at a cost of between 50 to 100 dollars per thousand cubic feet, if an efficient process were developed to treat low helium-bearing gases. He rightly points out that no private corporation can be expected to experiment on these lines, the work or research necessary well warrants State enterprise and, we may add, an Imperial backing. There is also a possibility of establishing a carbon black industry in Alberta, and the author thinks that a ready market could be found for this product providing it were sold at competitive prices with those current in Louisiana, the home of that industry

DEPTH OF SEISMIC FOCI.—An important paper on this subject by Dr S K Banerji, director of the Bombay and Alibag observatories, is published in the *Phil. Mag* (vol 49, pp 65-80) The method adopted is to estimate the effects of the depth of the focus on the amplitudes of the different phases of the seismogram, assuming that the corresponding waves have the same amplitude at unit distance from the source Taking the earth to be an infinite solid bounded by a plane, it is shown that, while the effect of the depth of the focus on the amplitudes of the primary and secondary waves at great epicentral distances is almost negligible, the amplitudes of the long-wave phase undergo a rapid decrease with increasing depth of focus If the depth were so great as 1000 km, the amplitude of the primary and secondary waves at the antipodes should be about $2\cdot7 \times 10^{87}$ times as great as that of the long waves. If the depth were 200 km, the amplitude of the former would be about 400 times as great as that of the latter If it were 100 km., the amplitude of the long waves would be about 55 times as great as that of the primary or secondary waves Roughly speaking, therefore, about 100 km or less is a possible depth for the seismic focus, while a depth of from 200 to 1000 km is probably much too great Taking the earth to be a spherical body, it is found that the depth is probably less than 100 km

SPECTRAL FREQUENCIES IN THE REGION BETWEEN LIGHT AND X-RAYS.—Two papers are contributed by M F Holweck to the *C.R. Acad Sci*, Paris, of January 26 and March 2, in which a method of investigation is described, using very soft X-rays produced by bombarding a molybdenum anticathode with slow electrons, the velocity of which corresponds to a small potential difference V Only the electrons from the first atomic levels are expelled, and the X-radiation forms a continuous spectrum without characteristic lines. The radiation is filtered through several sheets of celluloid, which has no discontinuity of absorption in the region investigated The ionisation produced in argon and hydrogen chloride, sulphide, phosphide, and silicide has been examined, the ionisation current being observed for different values of V, so as to obtain the curves showing the relation $i = f(V)$ for the different gases. These have singular points at the critical potentials, and the following values have been found for Bohr's L III, L II levels, including a determination for aluminium by another method:

Ar	Cl	S	P	Si	Al
$246\cdot5 \pm 1$	203 ± 1	163 ± 1	128 ± 2	98 ± 2	68 ± 2

These figures are compared with those of other observers, and are found to lie well on a Moseley

diagram. The figure for argon, after certain small corrections, gives for the wave-length 50·1 ±0·2 Å.U.

QUANTITATIVE ANALYSIS WITH THE X-RAY SPECTROSCOPE.—Messrs. R Glocker and W Frohnmeyer show, in the *Annalen der Physik* for February, that analysis by means of the bright line X-ray spectra of the elements does not always give satisfactory results, and they suggest a number of reasons for this They have developed a method in which the intensities in the absorption X-ray spectrum are measured, the substance to be investigated being placed between the crystal of the spectrometer and the photographic plate in the form of fine powder, a solution, a metal foil, or a plate Measurements of the intensity are made photometrically on the record, just outside and just inside the absorption band of the element dealt with, if λ_A is the wave-length at the band head, I_1 the intensity for $\lambda < \lambda_A$, I_2 the intensity for $\lambda > \lambda_A$, p the mass of the element in the path of the rays in grams per sq. cm., and c a characteristic constant for the element, $I_2/I_1 = l^{-cp}$ The characteristic constants have been determined for elements with atomic numbers from 42 to 90 for the K absorption band, and from 90 to 92 for the L_1 absorption band The effect of mixing other substances with the element to be determined has also been investigated The jump at the band head of an element is smaller when the absorption due to impurities increases If two elements with high and low atomic numbers are mixed the amount of the first can be determined with an accuracy of about ± 5 per cent Examples are given of the use of the method in determining the amount of barium in glass, of hafnium in minerals, and of the constituents of mixtures of salts

COLOUR PHOTOGRAPHY.—The "Jos-Pe" process of natural colour photography on paper is described in the April colour supplement of the *British Journal of Photography* The usual three negatives are made, and from these, prints are obtained by projection of any required size on plates coated with a gelatin-bromide emulsion containing very little of the silver salt The exposure of these plates is made through the glass, and they are developed in a pyrocatechin developer which contains no sulphite and has the property of locally hardening the gelatin in proportion to the amount of silver reduced After fixing, the unhardened gelatin is dissolved away in hot water, and there results a gelatin relief image slightly darkened by the reduced silver. To prepare a print, each plate is soaked in its proper dye solution, rinsed to remove the dye solution from the surface, and the gelatin coated transfer-paper is squeezed into contact with it. In a few minutes the transfer-paper has absorbed sufficient dye, and it is removed and squeezed in turn on to the other two plates The images on the printing-plates are so transparent that the registration offers no difficulty. If necessary a second application on either of the printing-plates may be made, and local corrections may be made by applying more colour with a brush

BERTHELOT'S BOMB.—In a communication to the *Comptes rendus* of the Paris Academy of Sciences of February 23, Prof C. Moureu describes the destruction of the original bomb calorimeter of Berthelot This historic instrument was being used during the War in experiments with reactions of an explosive nature and burst on December 16, 1918, fortunately without causing any personal injury, although Prof. Moureu mentions that some minutes earlier he had the bomb in his hands. The head of the bomb lodged in the ceiling of the laboratory, 16 feet above the working bench. This bomb had been in use for 30 years for the determination of heats of combustion, and, in spite of this long period of hard wear, was in perfect condition when it burst The question of its replacement was a difficult one on account of the present price of platinum. The original Berthelot bomb contained about 1300 grams of platinum, and at the time the instrument was built, this cost less than the same weight of gold The present price renders an exact reproduction impossible, and in collaboration with M P Landrieu, a new design of bomb has been worked out The complete inner lining of platinum has been retained, but the amount required has been reduced to 128 grams, partly by changing the form from a cylinder to a bottle with large neck, and partly by the use of a laminated sheet of platinum (0·2 mm.), gold (0 4 mm.), and copper (0 4 mm.), the whole being worked as one sheet The new pattern instrument has been at work in the laboratory of the Collège de France, and has proved satisfactory At the same time other changes have been made with the view of reducing the magnitude of the cooling constant, and calorimetric determinations can now be carried out with an accuracy of 1 in 1000

CONSUMPTION OF POWER IN COAL MINING.—The University of Illinois has recently published a Bulletin (No 144) entitled "Power Studies in Illinois Coal Mining," by Prof A J Hoskin and T Fraser, which consists of a careful study of the manner in which power is utilised in the various operations of coal mining in the State of Illinois As in all other countries, these collieries have of late years been resorting more and more to mechanical means of performing the various operations, and this has mainly made itself evident in an increased employment of electrical power Here, as elsewhere, colliery companies commenced by themselves generating the power which they needed in their mines, but of late years there has been an increasing tendency towards purchasing current from the electric supply companies, or, as the Americans call them, "utility companies," and it is pointed out that in some cases such companies are in a position to supply current at a lower cost than that at which the colliery companies themselves can generate it The net result of the increased use of power has been to diminish costs, but "some of the improvements have lowered costs of coal production per ton by merely increasing production rates, whilst other mechanical innovations have lessened costs by minimising labour" In order to determine the distribution of power consumption in the collieries, data were obtained from 50 representative mines, ranging from the smallest to the largest, from a daily output of 650 tons up to one of 5200 tons Excluding manual or animal power, it would appear that steam performs 42 per cent of the mechanical duties about these mines, and that 58 per cent of the energy employed is electric The average distribution of energy in all these coal mines is classified as follows Hoisting, 17·2 per cent., ventilation, 22 2 per cent., pumping, 5 per cent; mining, 22·1 per cent., haulage, 23 per cent., miscellaneous, 10 5 per cent Quite naturally, however, these averages vary between exceedingly wide limits: thus the percentage of the total energy consumption used for hoisting ranges from 1·4 per cent to 50·8 per cent., for ventilation, from 2·2 per cent to 55·9 per cent; for pumping, from 0·1 per cent. to 35·9 per cent; for mining, from 0 (where all the coal is cut by hand) to 45·7 per cent., for haulage, from 0 (where only mule haulage is employed) up to 51 per cent; whilst miscellaneous services absorb from 3·6 per cent to 23·9 per cent.

The International Geographical Congress.

THE International Geographical Congress, under the auspices of the Union Géographique Internationale, met at Alexandria and Cairo on March 28-April 9. One noticed well-known scientific men from France, Italy, Switzerland, Spain, Holland, Belgium, Poland, Yugoslavia, Greece, etc., as well as from England and Egypt. The deputations from Italy and from Poland seemed specially strong, while the French delegation included many leading members of the professoriate. The British group included Sir Francis Younghusband, who acted as its chief, Sir Charles Close, the honorary secretary of the Union Géographique Internationale, Maj.-Gen. Lord Edward Gleichen, Col. H. G. Lyons, Admiral Sir John Parry, Lieut.-Col. Craster, Dr. Newbigin, Profs. Roxby and Fleure, and Mr. W. W. Jervis.

The Congress owed its preliminary organisation to the Société Royale Géographique de l'Egypte, the secretary of which, M. Cattaoui Bey, worked very hard throughout for the success of the meeting. H.M. King Fuad honoured the Congress, in which he has taken great interest, with his presence at its opening session, and also received the members of the Congress on the first evening at the Royal Palace.

The scientific work of the Congress was organised in five sections, which met in the mornings and heard a number of papers, some of which were followed by valuable discussions. A few special addresses were given to the Congress as a whole, at sessions at which General Vaccheli, president of the Union Géographique Internationale, took the chair.

Lieut.-Col. Craster, on behalf of Major M'Leod, pleaded for reconsideration of the organisation, which is trying to promote the 1 in a 1,000,000 map scheme. That organisation is imperfect in the matter of co-operation between adjacent countries for common sheets, of placing sheets on sale in the world's great cities, and of financial support for the central bureau, which has suffered greatly through the vagaries of the international exchange markets. It is also felt that the regulations as to style of maps as laid down by a Conference at Paris have not proved satisfactory, and that different countries have executed the maps too differently. It was resolved to place the whole matter on the agenda for the next International Geographical Congress, to be held in England in 1928, and in the meantime to circularise all the nations concerned, in the hope of approximating to a common opinion.

M. de la Roncière gave an interesting summary of his well-known researches into discoveries in Africa in the Middle Ages, and showed how much was known and how much trade existed between oasis cities, for example, and the Italian republics. M. de la Roncière also exhibited a map found by him, which he showed reason to believe was a map contemporary with, and utilised by, Christopher Columbus.

Sir Francis Younghusband pleaded for better descriptive work in geography, urging that geographical writers should try to penetrate to the soul of the country they described, and should do this by learning to love the earth, as all great artists love the subjects at which they work. Prof. Collet gave a valuable paper from an English lady student in his laboratory, working under his direction. It showed how it was possible to obtain accurate photomicrographs of the layers of sediment on the floor of the Lake of Geneva. Slides were shown which made clear the succession of winter and summer layers, and allowed accurate estimation of their thicknesses.

Profs. Czekanowski and Stolyhwo brought forward methods of anthropological analyses and mapping, and a discussion followed, in which Prof. Biasutti and others took part. Father Bovier Lapierro gave a most valuable account of years of research concerning prehistoric Egypt. He has found numerous stations of various ages, within the Palæolithic epoch, especially around the Mokattam region, and it is greatly to be hoped that his work may be published *in extenso*. It raises many important points in various branches of study. The same worker further roused great interest by announcing a quite recent discovery of small but dolmen-like stone monuments in the eastern desert. This announcement was considered so important that a few members of the Congress adventured out with M. Bovier Lapierro to see these monuments. They need further examination, which the Rev. Father is undertaking, but there can be no doubt as to their interest; their age remains for the present a matter of speculation.

Prof. Arctowski presented contributions from his well-known researches in meteorology, some with special reference to attempts to ascertain periodicity of temperature variations for short periods. M. de Margerie, who presided over the section on physical geography, contributed to a plenary session of the Conference an eloquent and appropriate tribute to the work of the late Franz Schrader, emphasising Schrader's wonderful knowledge of the Pyrenees, and the great historical atlas which remains as one of the chief memorials of a lovable personality. M. Sadik Bey gave an interesting and valuable account of the geology of Sinai, and a number of other papers dealt with matters of Egyptian interest.

M. Demangeon opened a discussion on rural habitations and their distribution, in which he urged the need for re-examination of the work of Meitzen, and in the discussion which followed, Miss Lefevre, MM. Marinelli, Michotte, and others took part. Arrangements were made for publishing an account of the discussion in the *Geographical Teacher*, and for organisation of further inquiry with the view of a discussion with illustrative maps, at the 1928 Conference.

Though a visit to the famous Survey of Egypt was unfortunately omitted from the official programme, many members of the Congress arranged to spend some hours at this remarkable institution, which has created a huge map system that serves as the official property-registration for the whole of Egypt.

The Royal Geographical Society of Egypt had collected a large number of valuable large relief and geological and other models, which were much appreciated. The relief of the Aswan dam, geologically coloured, was specially eloquent.

On Friday April 3 was celebrated the jubilee of the Royal Geographical Society of Egypt, and the president of the Society gave a felicitous review of the Society's work in the great days of pioneering discovery. Representatives of the various nations offered their congratulations, those of the Royal Geographical Society of London being presented on behalf of the Society by Lord Edward Gleichen.

Naturally, visits to the unique Egyptian Museum, the Arab Museum and the mosques, the Coptic Museum and churches, the pyramids of Giza and of Saggara, the barrage of the Nile at the head of the delta, the observatory at Helwan, and many other places were made, and our Egyptian hosts showed the greatest generosity and kindness in this as in many other respects. Arrangements were made for visits, after the Congress, to Kharga oasis, Luxor, Aswan, Kosseir, and so on.

It was found that five sections gave the most practical distribution of the papers and the audience

at the Congress, and much experience was gained, which should prove useful for the Conference of 1928

Before the meetings at Cairo, three days were spent at Alexandria, where the museum, the site of the ancient Canopus, and several other features were visited, chiefly under the enthusiastic guidance of Prof Breccia

The overwhelming hospitality shown to the Congress will long remain as a vivid memory Many colleagues from various countries met for the first time, and were able to exchange opinions and thoughts on the many delightful excursions, notably on those on the Nile steamers. The warm sun and fresh breeze, the sunsets behind the pyramids, the minarets lighted for Ramadan, the citadel, and most of all the great river of history, form a picture which should make all who were present better geographers than they could be without a knowledge of the motherland of so much civilisation

The Preservation of Food.

It is probable that few people realise the attention to detail which is necessary when articles of food have to travel long distances and yet reach the consumer in a condition which compares favourably with the appearance and character of the same food in the fresh state Quite apart from the use of food preservatives, the storage of food at ordinary or low temperatures requires attention to a number of factors if success is to be obtained . to the investigation of these factors the Food Investigation Board has devoted a considerable amount of work, as revealed in its report for the year 1923 [1] The report commences with a short account of an expedition to Australia, which was sent out to investigate the cause of a disease of apples known as "brown heart," occurring during the transport of the fruit from that continent to Great Britain Following a short section on the theory of freezing, come the reports of the six committees set up by the Board to deal with various aspects of the problems of food storage in relation to different types of food The investigations have been carried on at various places, especially at the Low Temperature Research Station and the Biochemical Laboratory at Cambridge, at the Horticultural Research Station of the University of Bristol at Long Ashton, and in London, Manchester, and St Andrews About half of the report is occupied with an account of the investigations of the Fruit and Vegetables Committee, and this section can be conveniently considered together with the results obtained by the Australian Expedition

It has been found that the following factors affect the keeping properties of stored apples the soil and locality of the orchard, the age of the tree, the season and the presence of fungi on the fruit ; the maturity of the fruit when gathered and its grading and packing; the temperature, humidity, and composition of the atmosphere of the storage chamber The reports of the Expedition have been referred to in NATURE of February 7, p 207, and April 18, p 584 By regulating the temperature and composition of the air of the hold, the fruit can be kept in good condition , on the other hand, ventilation can be too efficient, since the removal of the carbon dioxide produced and the supplying of oxygen to replace that consumed hastens the process of ripening, which may thus be brought about before the fruit reaches the consumer Hence the ventilation should be so arranged that the carbon-dioxide percentage is kept at about 10

The problems of storing fruit in Great Britain have also been investigated : cold storage is usually superior to storage at room temperature, but in certain seasons this result may be reversed Any deterioration which occurs in cold store is usually of a non-parasitic type and similar to that found in Australian apples in transport to Great Britain, whereas in ordinary storage the deterioration is produced by fungal disease. The species of fungi causing this deterioration have been investigated, together with the path of invasion of the fruit : the spores appear to reach the fruit in the orchard itself, and to prevent this, improved orchard sanitation is necessary , once present, however, their development can be retarded by placing the fruit in cold store The work of this Committee also includes a number of chemical investigations on the fruit kept in storage, such as carbon-dioxide production, and changes in sugar and pectin content and in acidity, all of which will throw light on the processes occurring in the fruit during ripening and storage

Although foods of various kinds can be preserved well by freezing, it is not easy so to conduct the processes of freezing and thawing that the food is in an unchanged condition when it finally reaches the consumer. Thus, the yolk of frozen eggs may pass into a pasty state, the change being irreversible on thawing this can be prevented either by never allowing the temperature to fall below -6° C or by freezing and thawing with great rapidity The work of the Fish Preservation and Meat Committees has shown that irreversible changes may occur during the freezing and thawing of fish and meat, unless the freezing is carried out rapidly, as, for example, by immersion of the food material in cold brine , in this case the autolysis of the thawed food is similar to that of fresh meat or fish, whereas if the freezing is carried out in air, fluid separates from the tissues during freezing and drips away on thawing , in this fluid autolysis is rapid, but in the remaining tissues it appears to proceed at what may be called the normal rate An attempt was made to preserve the fish more satisfactorily by exposing it to ice containing an antiseptic , although the latter hindered the development of bacteria, which still occurred at this low temperature, yet the method was unsatisfactory, since the tissues took up considerable amounts of the antiseptic

The Oils and Fats Committee reports work on the series of glycerol methyl ethers, the glyceryl glucosides, the constitution of glycogen, and the synthesis of the higher aliphatic acids The formation of fat by yeasts has also been investigated , the fat is formed from the carbohydrate of the nutrient medium in the presence of oxygen, and more fat is stored if phosphorus is also present in the medium . the phosphate is taken up by the cells in association with the carbohydrate, and it is possible that a hexosephosphate forms a stage in the conversion of carbohydrate into fat This fat contains the growth vitamin A, which is probably synthesised directly by the yeast cells.

The Canned Food Committee has investigated the chemical changes occurring in fish during the processes of canning and storage It was found that the presence of soluble tin facilitated the production of certain degradation products of the nature of volatile bases.

The report as a whole is a good illustration of the fact that there can be no dividing line between the two branches of research which are sometimes designated as "pure" and "applied" respectively.

[1] Department of Scientific and Industrial Research Report of the Food Investigation Board for the year 1923 Pp iv+77+4 plates+14 charts. (London: H M. Stationery Office, 1924.) 3s. net.

Navigation and Fishing on the Ganges.

THE first of Mr. Hornell's two memoirs[1] deals with the various navigation appliances employed on the Ganges These are studied under two main groups, representing respectively the primitive and the advanced types The former comprises rafts, dug-outs, skins, and other rudimentary forms adapted to simple requirements. Inflated buffalo-skins, used either singly as floats to support a swimmer, or by associating together two or more to give buoyancy to a platform-raft, are still in use locally on the Ganges, just as they are on the Tigris, as direct survivals from the ancient Babylonian and Assyrian days It is curious that the skin-covered coracle, which also was used in ancient Mesopotamia, is not represented in this part of India, its absence being the more noteworthy since it is prevalent both in southern India and in the Trans-Himalayan regions (*e g* Tibet) On the Ganges its place seems to be taken by the *Tigari* of Eastern Bengal, a circular, round-bottomed pottery bowl, in which one man can sit and propel himself with a short paddle

Of the dug-out canoes, the most peculiar are those made from the stem of the Palmyra-palm (Borassus) The base of the stem is much swollen, and the canoe, retaining the natural shape, is thickened and rounded at one end and narrow at the truncated other end, which is usually plugged with clay These canoes are often used in pairs, lashed together to give stability The type occurs also on the Colair Lake in Madras Presidency

The difficulty and cost of obtaining large tree-trunks for making dug-outs is encouraging the increasing adoption of plank-built boats, of which Mr. Hornell describes several varieties, from the small, one-man *dinghi* to large barges and house-boats The author points out that the Gangetic built-boat types do not link up with types seen farther east (Burma, Siam, and China), but with western forms; and he urges the probability of a close link with the Mediterranean vessel-types. He suggests that these boat-designs may have been introduced by Dravidians who entered India through Baluchistan. He refers to the use of the *oculus* on some of the Gangetic vessels, and offers this as an important link with Egypt and the Mediterranean. In Fig 14 the *oculus* is described as being situate upon the "*stern*-head" and this evident misprint for "*stem*-head" occurs more than once in the text.

This treatise is a useful adjunct to one published by Mr Hornell in the same "Memoirs" in 1920 (7, pp 139-256)

The second memoir is devoted to the fishing methods of the Ganges, dealt with under three environmental conditions—estuarine, riverine, and lacustrine The first and last mainly involve shallow, still-water fishing, the second—by far the most important—is chiefly characterised by swift, deep waters The various appliances are described in detail. Spearing fish with simple, many-pointed, or harpoon-headed spears, and also shooting them with bow and arrow, are still practised extensively The art of trapping fish has been highly developed, great ingenuity being exhibited in designing and constructing the numerous varieties of traps The same may be said of the netting-gear, which has been even more specialised into a great diversity of types adapted to different quarries and varied waters. Line-fishing, with or without a rod, is also popular, and much ingenuity is evinced in the practice of ground-baiting The author has added an important item to the literature of fishing, which will prove of value when a long-wanted monograph is produced dealing with the primitive fishing methods of the world, their distribution and ethnological significance

In both these memoirs the illustrations are very good and clear. HENRY BALFOUR.

[1] "The Boats of the Ganges" and "The Fishing Methods of the Ganges," by J Hornell Memoirs of the Asiatic Society of Bengal, vol 8, No 3, 1924, pp 171-238 Rupees 2 13

Synthetic Methyl Alcohol.

THE first attempt to synthetise methyl alcohol by the catalytic reduction of carbon monoxide was apparently made by Sabatier and Senderens These experiments were unsuccessful, but French research workers have persevered on the problem and the manufacture of methyl alcohol is now an accomplished fact An accidental synthesis was carried out by the Badische Anilin- und Soda-Fabrik in 1913, during experiments carried out to investigate the possibilities of manufacturing liquid hydrocarbons by the catalytic reduction of carbon monoxide at high temperatures and pressures No attempt was made, however, to pursue the investigation In 1921 Calvert claimed to have obtained an 80 per cent yield of methyl alcohol by the action of hydrogen on water gas, and in the same year Patart, Inspecteur Général des Poudres, published his first patent A small plant was erected at Asnières and Patart's method was successfully applied

In Patart's process the gaseous mixture, containing two volumes of hydrogen to one of carbon monoxide, is compressed to 250-500 atmospheres and, after filtration, is passed over the electrically heated catalyst (400°) The gases are then cooled and the non-condensed portion re-circulated through the apparatus A suitable catalyst is zinc oxide, it yields a greenish liquid containing a greenish precipitate of metallic copper from the apparatus The liquid readily yields practically pure methyl alcohol on distillation with phosphoric acid, followed by a redistillation of the first portion of the distillate The final product has a somewhat disagreeable odour, but is perfectly free from aldehydes and ketones

The great difficulty in working this process is to avoid side reactions Above 300° and in the presence of certain catalysts (*e g* iron), carbon monoxide changes rapidly to the dioxide with deposition of carbon. The monoxide is also reduced to methane by hydrogen in the presence of nickel or iron Conditions must be carefully adjusted to avoid these side reactions Patart describes his process in some detail in the February issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, and discusses the prospects of its commercial adoption

More recent work, using metallic suboxides as catalysts, has been carried out by Audibert. Higher oxides of nickel and of copper are reduced by the reaction mixture of carbon monoxide and hydrogen *in situ*, and Audibert found that with these catalysts temperature is the controlling factor Between 225° C and some limit between 275° and 300° C., depending on the nature of the catalyst, methyl alcohol is the sole reduction product of carbon monoxide

Patents were taken out in Germany in 1922 for a process very similar to Patart's, and a plant was erected at Merseburg in 1923 capable of turning out about twenty tons of alcohol per day. This synthetic alcohol is now being exported by Germany in considerable quantities.

University and Educational Intelligence.

LONDON.—Prof F. J. Cole will deliver on May 1 and 8 at King's College, at 5 30, free public lectures on "The History of Protozoology"

The following free public lectures at University College are announced. "The Physiology of Muscle and Nerve," Prof A V Hill, on May 1, 8, 15, and 22, at 11, and "The Physical Environment of the Living Cell," Prof. A. V. Hill and Prof. J. C Drummond, on May 4, 11, 18, 25, June 8, 15, and 22, at 5 30

The latest date for the receipt of applications for grants from the Dixon Fund is May 14 Applications should be sent to the Academic Registrar, South Kensington

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THE Board of Education has issued a list (H M Stationery Office Price 6*d*.) in which are conveniently brought together the numerous vacations courses to be held this summer in England and Wales The courses are arranged alphabetically under four headings, according as they are being organised by the Board itself, by local educational authorities, by universities, or by other bodies Among the subjects of the courses are psychology (Brighton), mining science (Amman Valley, Swansea, and Camborne), agricultural subjects (Nantwich), geography (Cambridge and Leeds), higher mathematics (Bangor), and zoology (Oxford)

THE Secretaries of the Royal Society will receive until June 1 applications for a Mackinnon Research Studentship, value 300*l* per annum, tenable for two years with a possible extension, and for a Moseley Research Studentship of a like value and period The first-named studentship is awarded to further natural and physical science, including geology and astronomy, and original research and investigation in pathology; the second is to further experimental research in pathology, physics, and chemistry or other branches of science, but not in pure mathematics, astronomy, or any branch of science aiming at describing, cataloguing, or systematising The necessary application forms may be had from the Assistant Secretary of the Royal Society, Burlington House, Piccadilly, W 1

THE second series of "Methods and Problems of Medical Education" has been issued by the Division of Medical Education, Rockefeller Foundation It contains an introduction by Prof Rosenau of the Harvard Medical School on the sanitary survey as an instrument of instruction in medical schools, and the reproduction (by photo-lithography) of the report of a sanitary survey of Rochester, New Hampshire, carried out and reported by Mr Shields Warren while a third-year student in the Harvard Medical School The survey is a model of what such a survey should be, and reflects great credit on the medical curriculum of the Harvard School Nothing of the kind has been attempted in Great Britain, even in the curriculum for the future medical officer of health.

THE University College Committee of the University of London gives prominence in its report for the year ending February 28, 1925, to the need of additional funds for the equipment of the College laboratories for physical and electrical chemistry and engineering, for the new buildings for the Department of Zoology and Comparative Anatomy, and for additional museum cases and improvement of the animal houses in the Department of Applied Statistics An appendix to the report, showing the geographical distribution of students in 1923–24, gives the names of no less than fifty countries outside the United Kingdom The total number of students from these countries was 518, including 90 from India, 43 from the United States, 36 from Japan, 35 from Switzerland, 29 from Australia, 27 from France, and 22 each from South Africa, Holland, and Russia Among lecturers from abroad were 2 from Austria, 4 from the United States, 2 from Holland, 2 from France, and 1 each from Russia, Germany, Belgium, and Italy

NATIONAL physical deterioration, as disclosed by Army recruiting officers' reports, formed the subject of a recent leading article in the *Times* (Educational Supplement), which concluded with the remark that although all parties are agreed as to the evil, little is being done towards remedying it, and the process continues In the same issue appeared articles on the inadequacy of existing school buildings, on the excessive size of classes, on juvenile unemployment, and on the dangers involved in the schools turning out large numbers of young people who, having been educated without a thought of future work, cannot find work for which they are fitted For all these problems a solution is offered by the Calcutta University Poverty Problem Study lecturer, Capt J W Petavel, R E (retired), in his scheme for the organisation of educational labour colonies combining features of the Swiss labour colony and of trade and agricultural schools Capt Petavel, who has for some years conducted a polytechnic institute on lines intended to fit boys to work in co-operative organisations, obtained for his scheme the support of the late Vice-Chancellor of the University of Calcutta, Sir Asutosh Mookerjee, and many other prominent citizens of Calcutta, including the editor of *Capital*, who published a series of articles by him last January and February These have been republished by *Capital* in pamphlet form together with a number of other papers on "Unemployment and the Calcutta University Propaganda for a solution by Educational Colonies, Home-crofting, and Home-crafting"

THE Board of Education issues from time to time valuable memoranda on the teaching of some school subject These documents present the considered suggestions of the Board based on long observation in the schools and from the point of view of the educational discipline of future citizens Such a memorandum would be welcomed by all teachers of geography, many of whom have been endeavouring for many years to find the best methods of teaching a necessary but admittedly difficult subject The inquiries of the British Association Committee on Geography Teaching showed that remarkable unanimity prevailed among teachers as regards the purpose of geography, but extreme diversity marked the methods and practices of teaching At the request of this Committee, the Council of the Association has expressed to the Board of Education the hope that a memorandum will be issued on the teaching of geography There is of course no royal road in geography or any other subject, but it is an advantage to know what has been found expedient and useful It is admitted that the home region must form the laboratory of direct geographical observation, but how should this laboratory be used? What geographically are fundamentals in the teaching of the British Isles, the British Empire, the world? What are the best methods of keeping one's knowledge of the world up-to-date? A memorandum would pool experiences and give form and coherence to the subject without stereotyping the teaching.

Early Science at Oxford.

April 27, 1686 The Society gave Mr. Musgrave their thanks for ye care and paynes he has taken in executeing the office of Secretary

Dr Bagley's letter of Nov 26th 1683, and Dr Tyson's of December 6th, both concerning ye *Lumbricus latus* were read

Dr Smith communicated part of a letter from France, wherein some mention was made of young dogs recovered from drowning, by some salts

Mr. Musgrave communicated a Discourse which he received from a freind of his concerning *Dyalling* Mr Caswell was desired to give the Society some account of it the next meeting.

1687. Mr President was pleased to communicate a Discourse concerning the Regulation of Easter, for 2000 years, and the moveable feasts according to the computation of the Church of England

Mr Caswell gave an account of some bodys weighed hydrostatically, by weighing them in aer and water 'Twas observd by him that the Calculus humanus is lighter in specie than any known sort of Stones

April 28, 1685 A Letter from Mr William Molyneux dated Dublin April 4 was read, in it was contained a Transcript of Sir William Petty's *Supellex Philosophica*, as it was presented to the Dublin Society, which also was read, and the thankes of ye Society ordered to be returned for it

Mr. Aston communicated an account of ye Curiosities brought from Ceylon by Dr Heerman, Professor of Botanics at Leyden

A Letter from Dr Pierce of Bath dated April 11 was read, it gave a farther relation of the Evets found alive in ye middle of a stone—Dr Cole of Worcester then described a case of Haemophoia, after which Mr Bainbrig affirm'd, that ye little end of a Dutch Tobacco-pipe (ye piece about 2 inches in length) having been thrust into ye bladder by a Boy was cut out, and is now to be seen at Leyden

A Letter from Mr Aston was read containing a proposall of Dr Lister's of cutting for ye stone by entering ye Abdomen a little above ye Os Pubis, and opening the ffund of the bladder, on which account Mr Bainbrig informed the Society, that one, Colbron, a Chirurgeon at Haysham in Sussex, has taken out the stone of the bladder this way with successe Mr Bainbrig is desired by the Society to procure a full Relation of the particulars of this Operation, and Mr Pigot is desired to try ye Experiment on a Dog.

April 29, 1684. Mr President, takeing ye chair, gave order for ye reading of a letter dated April 24, from Mr Aston, which affirmed, that ye experiment of makeing Plaister of Paris perspicuous, by striking turpentine thro it, was tried, and succeeded, before ye Royall Society The substance mentiond in ye Minutes of Aprill ye 15th, and sometimes supposd to be a petrifyed heel of a shooe, breaking when bor'd, ye peices of it were produced, and judged to have been *allwais* stone This gave occasion to some discourse, concerning such stones as are of a shape resembling some other body in nature, and are not found in beds, of which sort ye stone now mentiond is an example and Dr Plott acquainted ye Society, that he found a stone in Staffordshire in form like ye *heart* of a pullet, haveing lines in it, answering to ye coronary vessells of that muscle.

A Letter from Dr Huntingdon to Dr Plott, concerning ye porphyry pillars in Ægypt, was read: in it were enclosed ye draughts of two Pillars taken in that place This letter being written at ye request of this Society, it was order'd that our thanks should be returnd to Dr Huntingdon for this obligation

Societies and Academies.

LONDON.

Geological Society, March 11.—O. T. **Jones**: The geology of the Llandovery district (Carmarthenshire). The district lies east of the town of Llandovery, and extends for about 10 miles from north-east to south-west It is divisible into a northern area and a southern area In each area the succession is fairly complete, but in between them it is greatly attenuated. In proceeding from south to north, certain lithological changes have been noted in the Lower Llandovery. The fauna in the rocks appears in the main to have been drifted into the area from an adjoining tract, lying probably nearer to the shore-line. In addition to the differential subsidence and uplift along lines trending north-east and south-west, there is evidence of repeated elevation and depression along nearly east-and-west axes The axes of these transverse movements appear to have persisted during the whole of the Llandovery epoch, but there is no evidence of them in the Wenlock rocks.—G. **Andrew**. (1) The Llandovery and associated rocks of Garth (Brecon-shire) The Llandovery rocks lie north-west of Garth railway station, and extend from there in the direction of Newbridge The Lower Llandovery rocks overlie the Bala with a sharp boundary, but with apparent conformity The Middle Llandovery occurs in one small outcrop in the centre of the area, and is rapidly overstepped by the Upper Llandovery in both directions The Upper Llandovery consists of two types, a lower comprising sandy mudstones with *Pentamerus oblongus*, etc., and an upper of pale mudstones ("Tarannon Pale Shales") (2) The relations between the Llandovery rocks of Llandovery and those of Garth At Garth, as at Llandovery, the Lower and Middle Llandovery rocks are overstepped both north and south by Upper Llandovery or Wenlock deposits At Garth they crop out in an elongated oval area, at Llandovery they form two roughly oval areas The Middle Llandovery and the higher divisions of the Lower Llandovery are represented only in the central regions These distributions are due to the fact that differential movements along nearly east-and-west axes (that is, transversely to the present strike) were in progress during the Llandovery epoch The regions where the older Llandovery rocks are most complete were regions of persistent subsidence The axes of elevation in both areas cross the present strike at practically regular intervals of about 5 miles, and the areas of subsidence are situated nearly midway between them

Linnean Society, March 19.—S. **Hirst**: Species of mites of the family Trombidiidæ found on lizards When more than one form occurs on the same host, a flattened form lives under the scales, and a rounded form between the toes or toe pads. In view of the considerable differences in the shape of the setæ, etc., these are regarded at present as distinct species.—Mrs Muriel **Roach**: A study of the physiology of certain soil algæ in pure culture. Although a very few species carried on the synthesis of organic substance from carbon-dioxide and water through the agency of sunlight, the great majority of those studied grew much better when supplied with an additional source of carbon, glucose being especially favourable to many species A single species was selected for a more detailed investigation of the effect of different organic substances on its growth in liquid media The alga was able to grow in complete darkness, given a suitable supply of food, at about half the rate that it grew in the same medium in the light. The logarithmic values of the bulk for the first nine

or ten days, in media completely favourable to the growth of the organism, lie on a straight line The data indicate the importance of the compound interest law which evidently underlies the growth of the organism during the initial part of its growth The theory of the auto-catalytic nature of growth does not appear to hold —J M **Brown** Some Collembola from Mesopotamia Fifteen species of Collembola collected mainly in the neighbourhood of Bagdad and Amara, in Mesopotamia Ten species and one variety are regarded as new. The Collembolan fauna of Mesopotamia shows much closer affinity with that of the Palæarctic than with that of either the Oriental or the Ethiopian regions

CAMBRIDGE

Philosophical Society, March 2 —H Munro **Fox** (1) Biology of the Suez Canal. (2) The effect of light on the vertical movement of aquatic organisms — J **Brill** On a group having the Lorentz group for a sub-group.—A. W **Veater** On transvectant series — E V **Appleton** and M A F **Barnett** A note on wireless signal strength measurements made during the solar eclipse of January 24, 1925 Measurements at Cambridge on short wave wireless signals from London have shown that the signal intensity exhibits variations which, though practically inappreciable during the day, become apparent about sunset and continue throughout the night Typical sunset variations were found to be associated with the recent solar eclipse The variations are attributed to interference between the direct ray along the ground and an indirect ray returned from the upper atmosphere Such an indirect ray may be produced by ionic deviation without undue absorption if the mean free path of the effective ions is large, as suggested by Larmor If the carriers are electrons, however, the action of the earth's magnetic field on the phase velocity of the radiation cannot be neglected The possibility of a violation of the reciprocity relation between two wireless stations is thus suggested (*v.* also NATURE, March 7, p 333) —H W **Turnbull** A geometrical treatment of the correspondence between lines in three-fold space and points of a quadric in five-fold space —J B S **Haldane** The origin of the potential differences between the interior and exterior of cells —V. **Nath**. Spermatogenesis of *Lithobius forficatus* —J **Gray** The mechanism of cell-division (II.) —J T **Saunders**. The trichocysts of Paramœcium

EDINBURGH

Royal Society, March 23 —Andrew **Balfour** Reflections on malaria Discussing the geographical distribution of malaria, special reference was made to the case of Scotland Formerly malaria was prevalent in Scotland, but it has now declined Anophelines still abound in Scotland, and it is quite possible that indigenous cases of malaria still occur A combined mosquito and malaria survey might well be undertaken, if only from the scientific and academic point of view In discussing malaria as a cause of death, emphasis was laid on the condition of liver failure which so often occurs The value of the splenic index as a diagnostic method was considered, and its limitations defined The introduction of stovarsol as a rival to quinine in the treatment of malaria and the nature of the malaria toxin were discussed.

MANCHESTER.

Literary and Philosophical Society, February 17:— J. M. **Gulland** and R. **Robinson**: The constitution of codeine and thebaine. Experimental evidence was adduced in favour of the assumption that dihydrooxycodeinone contains the group —CO—CH_2— Thebaine and codeine are now regarded as containing the groups —C(OMe)=CH—CH=C< and —CH(OH)—CH=CH— respectively, whilst the ethanamine chain —CH_2 CH_2—NMe— connects positions 9 and 13 in the phenanthrene ring The new formulæ are closely allied to the bridge formulæ previously suggested

March 3 —A **Lapworth**. (1) A comparison of some properties of cyanohydrins, carboxylic acids and phenols The abnormalities of the $\cdot CO_2H$ group are notorious It is now shown that the charged (CO_2) radicle of the carboxylic acid *ion* behaves as if it were a single atom, and that on this conception the relative strengths of most *meta*- and *para*- substituted phenols, anilines, and benzoic acids are in excellent harmony with the application previously made of the principle of induced alternate polarities to the affinity constants of the cresols (2) Replaceability of halogen atoms by hydrogen atoms a general rule Some ions, such as H' and diazonium ions, some elements, including ozone, the halogens, and some compounds, including hypochlorous acid, carbonyl compounds, and $\alpha\beta$-unsaturated ketones, etc., have some properties in common and are termed "cationoid" Ions, such as CN', C C R', OEt', OH', the negative ions of *sodio*-malonic ester, and some non-ionised compounds such as NH_3, ethylenic and acetylenic hydrocarbons, phenol ethers and vinyl ethers, have other properties in common, and are termed "anionoid" The "anionoid" properties of ethylenic hydrocarbons are held to be closely related to Thomson's observation that methyl is frequently observed in vacuum tubes with a positive charge, but never with a negative charge The addition of a negatively charged ion to one of a pair of doubly-bound carbon atoms would leave the other as a tervalent carbon atom with a negative charge These generalisations are closely related to the ease of replaceability of a halogen atom by hydrogen, and the following rule is stated If X-H is an acid or compound in which H may be displaced by the direct action of an alkali or of a metal, then the halogen in X-Cl, X-Br, X-I will have some "cationoid" properties, and will be easily replaced by hydrogen This rule is true whether XH is a so-called "tautomeric system" or not

PARIS

Academy of Sciences, March 9 —A **Desgrez**, H **Bierry**, and L **Lescœur** The blood globules and alkaline reserve —S **Winogradsky** A method for estimating the nitrogen fixing power of soils The medium chosen is a silica gel, for the preparation of which exact details are given The number of azobacters is determined in the course of the operation, the amount of nitrogen fixed being estimated by the usual Kjeldahl method It is claimed for the method that it can be used by agricultural chemists who are not experts in microbiology —Luc Picart was elected corresponding member for the section of astronomy in succession to the late M Stéphan —Sir John Russell was elected a corresponding member for the section of rural economy in succession to M Winogradsky, elected foreign associate.—M **Légaut**: Skew algebraical curves —Gaston **Julia**. Series of iteration and quasi-analytic functions —Pierre **Humbert** Zonal hyperspherical functions —Léon **Pomey**. The theorem of existence and two modes of representation of the solutions of ordinary differential equations.—W. **Stozek**. The direction of harmonic functions in the neighbourhood of an exceptional point —A **Lafay**: The eddy currents of rotating cylinders —Léon **Bloch**,

Eugène **Bloch**, and Georges **Déjardin**: The spark spectrum of neon. Wave-lengths and intensities of the lines of the neon spark spectrum are given for wave-lengths between 4922 and 2757.—M. **Charron**: The resultants of the radiation pressures on the walls of any cavity whatever.—Pierre **Goby**: Stereoscopic microradiography in relief and in pseudo-relief: the stereomicroradiograph.—Stefan **Triandafil**: The influence of acidity on the galvanic polarisation of nickel.—— **Tourneux** and Mlle **Pernot**. The aqueous and acetone solutions of potassium bromo- and iodomercurates.—Fred **Vlès** and Edmond **Vellinger**: Remarks on the variations of the rotatory power of tartaric acid as a function of the P_H. The relation between the rotatory power and hydrogen-ion concentration of tartaric acid has been studied experimentally over the range P_H 0-14. By applying the usual formula for the dissociation equilibria of dibasic acids and calculating the rotation as the sum, for each P_H, of the rotations of the two ions and its residue of dissociation, the experimental results are explained.—— **Lemarchand**: The carrying down of magnesium by calcium oxalate.—— **Yvon**: Syntheses made starting with the sodium derivative and the mixed magnesium derivative of methylacetylene.—H **Rosset**: Phosphorus chloronitride $PNCl_2$ treated in toluene solution with phenylmagnesium bromide gave as one of the products of the reaction the compound $(PN(C_6H_5)_2)_3$. The constitution developed for this substance is based on the formula attributed to phosphorus chloronitride by Wichelhaus and Stokes.—Marcel **Godchot**: The two 1.3-dimethyl-4 cyclohexanones and the corresponding dimethylcyclohexanols. The existence of four 1.3-dimethylcyclohexanols is proved.—A **Demolon**: The texture of the quaternary sediments and the soils derived from it.—Jovan **Cvijic**: The Merokarst.—L. **Lutz**: The specificity of some hymenomycetes growing on wood. Some of these fungi grow exclusively on certain species of plants, and this peculiarity has been supposed to be due to the presence in these plants of substances necessary to the life of the parasitic fungi. The experiments described tend to show that the specificity of these fungi is not due to the presence of suitable nutritive substances, but, on the contrary, to the presence or absence of certain substances injurious to the growth of the fungus.—J. **Nageotte**: The extreme contraction of striated muscle in the frog.—Léon **Blum** and Maurice **Delaville**: The study of the modifications of the blood and humours by ultrafiltration.—A. **Rochon-Duvigneand**, E. **Bourdelle**, and J. **Dubar**: The determination of the monocular anatomical visual field of the horse by the method of the transcleral image.—— **Abelous**, **Argoud**, and **Soula**. The structural modifications of certain organs, especially the pancreas, in animals without spleen.—L. **Mercier** and Raymond **Poisson**: Hens with crossed beaks. A coaptation of mechanical origin.—Robert **Weill**. Experimental retardation of the nematocysts in the Cœlenterata. Rendering permeable the capsular wall.—Boris **Ephrussi**: The fecundation membrane of the egg of the sea-urchin (*Paracentrotus lividus*). The action of the cœlomic liquid.

March 16.—Paul **Appell**: Extension of a theorem of Monge.—P. **Widal**, P. **Abrami**, **Diaconescu**, and **Gruber**: Digestive hæmoclasia and the state of neuro-vegetative tonus. Objection has been taken to some of the earlier experiments published by the authors on the ground that there is insufficient proof that the results are wholly due to the condition of the liver. Additional experiments have been carried out, specially arranged to test the validity of this objection. The results confirm the original experiments.—André **Blondel**: A method of harmonic analysis of the waves of alternating currents by comparison with a polyharmonic standard alternator.—J. B. **Senderens**: The preparation of cyclohexenols by the catalytic dehydrogenation of cyclohexanediols. By testing the cyclohexanediols (resorcite, quinite) with from 3 to 4 per cent. of diluted sulphuric acid ($H_2SO_4 + 3H_2O$) a mixture of cyclohexadienes and cyclohexenol is obtained, and the conditions can be arranged to give either the hydrocarbon or alcohol as the main product. Details of the preparation, properties, and reactions of Δ_3-cyclohexenol from resorcite and from quinite are given.—Ph. **Glangeaud**: The rôle of the secondary volcanoes in the Monts Dore massif during the glacial periods. The volcano of Saint-Pierre-Colamine (Puy-de-Dôme). The existing topography of the Sancy volcano is the result of the action of numerous secondary volcanoes arising on its sides, afterwards brought into relief by glacial action.—M. René Kœhler was elected a corresponding member for the section of anatomy and zoology.—— **Kraïtchik**: Fermat's numbers.—G. Y. **Rainich**: A representation of surfaces.—Paul **Urysohn**: A metric universal space.—Maurice **Fréchet**: The notion of the differential in general analysis.—Henri **Milloux**: Meromorph functions with asymptotic value and the theorem of Picard.—St. **Kempisty**: A new method of integration of measurable functions not capable of summation.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1924. Details of observations on spots and faculæ made on 60 days during the quarter.—Aubusson de **Cavarlay** and Descours **Desacres**: An automatic method of drawing roads. The apparatus, placed upon a vehicle moving over a road, records the plan of the road in three dimensions.—F. **Baldet**: The third negative group of carbon, the so-called comet-tail spectrum. Extension of the red end and the structure of the bands. The carbon monoxide was under a pressure of 10^{-4} mm., the spectrum being induced by electronic bombardment, with 20 minutes' exposure of the plate. This reproduces exactly, with the same relative intensities of the bands, and in the minutest detail, the well-known comet-tail spectrum.—J. **Laffay**: The spark spectrum of mercury in the extreme red.—Jean **Lecomte**: The infra-red absorption spectrum of the alcohol function. By the use of a fluorspar prism, the region 2·75 μ to 8 μ has been studied. The mono-alcohols show two zones of strong absorption from 3 μ to 3·5 μ and from 6·85 μ to 8 μ. Details of the absorption bands of twenty-six alcohols are given.—E. **Huguenard**, A. **Magnan**, and A. **Planiol**: A hot-wire apparatus for the determination of great altitudes. A modification of the hot-wire anemometer; at a height of 14,000 metres its sensibility is nearly eight times that of a barometer.—Mlle Irène **Curie**: The homogeneity of the initial velocities of the α rays of polonium. There are no indications of differences of initial velocities of the α rays of polonium. If uniform distribution of velocities is assumed, the extreme deviation does not exceed 0·3 per cent.—Louis Jacques **Simon**: The relation between the structure of the unsaturated mono-carboxylic acids and their comparative sulphochromic oxidation.—J. **Orcel**: Two clinochlores containing chromium from Togo.—Jean **Jung**: Some types of crushed rocks from the Vosges.—Louis **Barrabé**: The nature of an eruptive massif, the "Antatika-Ambereny," from the west of Madagascar.—L. **Cayeux**: The relative age of the phthanites and dolomites of the carboniferous limestone of the North of France and of Belgium.—J. **Savornin**: The Djebel Ayachi (Morocco).—J. **Thoulet**. Submarine volcanoes at great depths.—Gabriel **Guilbert**: The causes

of the rapid destruction of cyclones.—Paul **Guérin**: The anther of the Gentianaceæ. The development of the pollen sac.—Pierre **Lesage**: Extension of acquired character and facts of heredity in *Lepidium sativum* watered with salt water. The alteration in the seed produced by salt water is an acquired character preserved after three generations in the absence of salt.—A. **Maige**: The evolution and "greening" of the plasts in the cotyledon cells of various leguminous plants during germination.—M. **Bridel** and C. **Charaux**: On an unstable glucosidic complex in the bark of the stem of *Rhamnus cathartica*. A complex glucoside extracted from the bark gives on hydrolysis primeverose and derivatives of oxymethylanthraquinone.—E. and G. **Nicolas**: Hexamethylenetetramine can serve as a food for plants. New researches on bean and white mustard.—Mlle F. **Coupin**: The state of the brain at birth in the chimpanzee.—R. **Herpin**: Egg production and development in a sedentary polychetal annelid, *Nicolea zostericola*.—Auguste **Lumière**: Some new anticoagulating bodies of definite chemical composition. Of eighteen compounds studied, five have shown a high anticoagulating power. Of these, sodium mucate is anticoagulating at a concentration of 0·4 per cent and has no toxic power.—Emile F. **Terroine** and H. **Spindler**: The influence of various methods of pasteurisation by heating on the digestibility of the albumenoid and mineral constituents of milk. Three methods were compared: heating to 63° C. for 25 minutes with stirring, heating to 95° C., and the Stassano method. None of the methods interferes with the digestibility of the milk.—Jules **Amar**: Mercurial poisoning and vital coagulation.—A. **Malaquin**: The germinal cells (gonocytes) are, in the course of the asexual reproduction of *Salmacina Dysteri*, the source of the blastogenic proliferation.—Marc **Romieu**: A new chemical reaction of dry proteid materials applicable to histochemistry. Sirupy phosphoric acid at about 50° C. gives a purple changing to violet with proteids. It appears to be a tryptophane reaction and is not given by gelatin.—Ph. **Joyet-Lavergne**: The reactions of a tissue to parasitism; lipoidogenesis and lipogenesis.

ROME

Royal Academy of the Lincei, December 7.—Gabriella **Armellini Conti** and G. **Armellini**: Visual brightness of lunar seas. The fact that the mean brightness of lunar seas is about 0·048 and that of the land areas about 0·096 indicates that the seas represent gigantic laval and basaltic lakes, whereas the land area is constituted largely of trachite and pumice.—M. **La Rosa**: Radial velocities and the ballistic theory of variable stars.—Luigi **Palazzo**: Magnetic determinations in the larger islands of the Mediterranean Sea.—Secondo **Franchi**: New traces of overthrust in the Western Alps.—Mario **Manarini**: The problem of primitive functions.—Paolo **Stranco**: Deduction and interpretation of some Einsteinian ds^2 symmetrical about an axis.—L. **Matteuzzi**: Determination of forced and free seiches by means of a Volterra's integral equation of the second species.—Bruno **Finzi**: A new hydrodynamic paradox.—Vittorio **Nobile**: The possibility of a rigorously rational arrangement of the fundamentals of stellar position astronomy.—Giorgio **Abetti**: Spectroscopic parallaxes of the stars belonging to Secchi's first type.—Remo **de Fazi**: Studies on the indones. VI. Methods of preparing indones.—P. **Leone**: Organo-metallic compounds of aluminium. Various aluminium alkyl halides and also aluminium phenyl iodide have been prepared by boiling the alkyl halides, in very dry condition, with metallic aluminium.—Paolo **Principi**: New observations on the geology of the deep valley of Tevere.—E. **Onorato**: Celestine from S. Gaudenzio (Senegal).—E. **Caroli**: A cavitied Mysidacea (*Spelæomysis bottazzii*) from Terra d' Otranto.—S. **Sergi**: The myorabdotic cellular groups of the lumbo-sacral region of the spinal medulla of the chimpanzee.

January 18.—F. **Cavara**: Floral atrophy in *Phœnix dactylifera* from Cyrenaica. The atrophy to which the male flower of the date palm is sometimes subject in the neighbourhood of Benghazi is shown to be due to attack by an organism which belongs to the Mucedineæ and is reproduced only by conidia, for this organism, previously not described, the name *Mauginiella Scaettæ* is proposed.—Fil. **Bottazzi**: Influence of temperature on the tissues and on their colloidal components. VII. Rigidity caused by cold.—Luigi **Fantappiè**: Reduction of Pincherle's distributive operations to Volterra's linear functionals.—F. **Vercelli**: Results obtained during the cruise of the Italian royal ship *Marsigli* in the Straits of Messina. This paper consists solely of tidal data.—E. **Fermi**: Collision between hydrogen nuclei and atoms. The collision between a nucleus and an atom of hydrogen results finally in two nuclei and an electron, all separate. When the relative energy of the collision is greater than that of ionisation, ionisation may occur continuously.—Maria **De-Angelis**: Presence of vesuvianite in the asbestiferous deposits of Val Malenco.—Roberto **Savelli**: Transmission of mutations through inter-specific hybridisations, procedure in the first series of experiments. Apart from its great technical limitations, inter-specific hybridisation repeats the results of pure succession and shows that, whether the direct physiological cause of the somatic extrinsications of the mutation be of hormonic or other character, its genetic substrate consists of a Mendelian unit.—Mario **Gianotti**: Variations produced in the ammonia content of the blood by exertion at high and low altitudes. During a state of rest, the blood of a human being at a great altitude (more than 4000 metres) contains more ammonia than on the plains, this phenomenon may be explained by the acapnia produced by rarefied air. Since, then, the blood exhibits diminished alkalinity at a height, fatigue will the more readily result in a condition of acidosis which will require the circulation of abnormally large amounts of ammonia.—A. **Rabbero**: Action of sea-bathing on the reaction of the blood. Sea-bathing, during which continued swimming is indulged in, is followed, not only by vigorous pulmonary ventilation and increased elimination of carbon dioxide, but also by diminished power of the blood to resist changes in its reaction. The bases remaining in the blood are rapidly expelled, presumably by way of the kidneys.—Constantino **Gorini**: Further investigations on mammary microflora.

VIENNA

Academy of Sciences, February 12.—A. **Bachofen-Echt**: The discovery of iguanodon tracks in the Neocomian of the island of Brioni near Pola. Near Cape Rocca in Brioni the strata of Neocomian limestone are almost exactly horizontal. The massive slabs of easily worked fine-grained stone have been quarried back from the cliff edge. Ripple marks show that in the chalk era there was a flat shore here. Two sorts of tracks are found—a three-toed footprint 26 cm. long, another 13 cm. long, perhaps iguanodons of different ages, also five-toed tracks, perhaps tortoises.—L. **Waldmann**: The geological structure of the primitive rocks between the Moldau and Danube on the survey sheet Gmünd. The principal rocks are orthogneiss, amphibolite, granulite, granite-gneiss, etc.—R. **Danzer**: Organic compounds of lead.

Official Publications Received.

Department of Commerce, U S. Coast and Geodetic Survey Serial No. 286: Tides and Currents in New York Harbor By H A. Marmer (Special Publication No 111) Pp v+174 (Washington Government Printing Office) 80 cents

The Carnegie Foundation for the Advancement of Teaching Nineteenth Annual Report of the President and of the Treasurer Pp viii+286 (New York)

Ministry of Agriculture, Egypt Technical and Scientific Service Bulletin No 47 Cotton Growing in relation to Climate in Egypt and the Sudan By C B Williams Pp ii+81+9 plates Bulletin No 56: The Buff-Backed Egret (*Ardea Ibis*, L., Arabic *Abu Qerdan*) as a Factor in Egyptian Agriculture By T W Kirkpatrick. Pp. ii+28 (Cairo Government Publications Office) 5 P T each.

Board of Education Syllabus of the Science Scholarships Examination, 1926. Pp. 24 (London H M. Stationery Office) 6d. net

Sixth Annual Report of the Governors of the Imperial Mineral Resources Bureau Pp. 25. (London.)

Stonyhurst College Observatory Results of Geophysical and Solar Observations, 1924, with Report and Notes of the Director, Rev A. L. Cortie Pp. xix+44 (Blackburn)

The University of Chicago: Publications of the Yerkes Observatory, Vol 3, Part 4 The Forms and Motions of the Solar Prominences By Edison Pettit Pp v+205-240+plates 27 37 (Chicago University of Chicago Press)

University Grants Committee Report, including Returns from Universities and University Colleges in Receipt of Treasury Grant, Academic Year 1923-1924 Pp 44 (London H.M Stationery Office) 3s 6d net.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland Vol 54, 1924, July to December Pp 211-370+15+x (London: Royal Anthropological Institute) 15s. net

United States Department of Agriculture Department Bulletin No 1281: Relative Utilization of Energy in Milk Production and Body Increase of Dairy Cows By J August Fries, Winifred Waite Braman and Donald C. Cochrane Pp 36. (Washington Government Printing Office.) 10 cents

Department of the Interior Bureau of Education Bulletin, 1924, No. 31 Statistics of State School Systems, 1921-22 Prepared under the Direction of Frank M Phillips Pp 42 5 cents. Bulletin, 1924, No 38: Statistical Survey of Education, 1921-1922 By Frank M Phillips Pp. 30 5 cents Bulletin, 1924, No 35 The Trend of College Entrance Requirements, 1913-1922 By Harry Charles McKown Pp. iv+172 20 cents. (Washington Government Printing Office)

Records of the Albany Museum. Vol. 3, Part 4, March 6th Pp 257-368+plates 9-19 (Grahamstown) 10s

Ministry of Public Works, Egypt Physical Department Paper No 17 The Upper Currents of the Atmosphere in Egypt and the Sudan By L J Sutton Pp iv+136+18 plates (Cairo Government Publications Office) 10 P T

Reports of the Council and Auditors of the Zoological Society of London for the Year 1924, prepared for the Annual General Meeting to be held at the Society's Offices in Regent's Park on Wednesday, April 29th, 1925 Pp 79 (London)

Ministry of Agriculture, Egypt Technical and Scientific Service Bulletin No 54 Notes on the Fungus *Rhizopus Nigricans* Ehr., in Relation to Insect Pests of the Cotton Plant in Egypt By T W Kirkpatrick Pp ii+28. (Cairo Government Publications Office) 5 P T.

British Museum (Natural History). British Birds Summer Visitors. Series No 2, Set C18 5 picture postcards 1s Series No. 3, Set C14. 5 picture postcards 1s British Flowering Plants Series No 5, Set F8 5 picture postcards 1s Series No 6, Set F9 5 picture postcards. 1s Crustacea Series No 1 Crabs and Lobsters Set L8 5 picture postcards 6d Colour Changes in Flatfishes Set M2 5 picture post cards 6d (London: British Museum (Natural History))

Diary of Societies.

SATURDAY, APRIL 25

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W P. Pycraft: Use and Disuse and their Effect on the Bodily Structure of Animals (I.).

MONDAY, APRIL 27.

ROYAL IRISH ACADEMY, at 4 15.

INSTITUTE OF ACTUARIES, at 5.—W Palin Elderton and A. H. Rowell: Some Approximations from Valuation Statistics.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—Exhibition of Industrial Kinematograph Films

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on Tyne), at 7 15.—Annual General Meeting

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College Glasgow), at 7 30.—M Platt: The Accessibility of the Pleasure Car Chassis.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. S S Brame. Motor Fuels (Howard Lectures) (II.)

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Clinical Evening

FARADAY SOCIETY (at Chemical Society), at 8.—A. E. Oliard: Adhesion of Deposited Nickel to the Base Metal.—H. Sutton: The Brittleness of Zinc Plated Steel.—W. A. Naish. The Partition of Silver between Lead and Zinc.—H J Poole: The Elasticity of Gelatin Jellies and its Bearing on their Physical Structure and Chemical Equilibria.—Dr E. K Rideal: Note on the Reduction Potential of Dicyanquinhydrone.—D. B. Macleod: (a) Some Physical Properties of Water; (b) The Relation between the Viscosities of Liquids and their Molecular Weight.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. P. Skrine: The Alps of Kungur

TUESDAY, APRIL 28.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15.—Dr H. H Poole. The Use of Photo Electric Cells in Submarine Photometry.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5 15.—Prof. J Barcroft. Some Effects of Climate on the Circulation (II).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Prof. E. Leschke: Metabolism and the Sympathetic System.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—D. M. Proctor. Steam Accumulation

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—M Platt The Accessibility of the Pleasure Car Chassis

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—C Friese-Greene Latest Improvements in the Friese-Greene Colour Process.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-on Tyne), at 7 30.—Annual General Meeting

WEDNESDAY, APRIL 29

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. Balfour The Trend of Modern Hygiene

THURSDAY, APRIL 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5 15.—F. Kingdon Ward: Plant Hunting on the Roof of the World.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute) (Annual Meeting), at 5 30.—At 6.—Dr. C W. Kimmins: Progress of Child Study in America

INSTITUTION OF CIVIL ENGINEERS (Birmingham and District Association) (at Chamber of Commerce, Birmingham), at 6.

FRIDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St Mary's Parsonage, Manchester), at 7.—Dr. S S Zilva: Recent Progress in Vitamin Research.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Group

JUNIOR INSTITUTION OF ENGINEERS, at 7 30.—A. A Fairfax: Pumps and Pumping Problems

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.

PHILOLOGICAL SOCIETY (Anniversary Meeting) (at University College), at 8.—Presidential Address.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8 30.—Annual General Meeting

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof W. L. Bragg: Crystalline Structure of Inorganic Salts.

SATURDAY, MAY 2.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. P. Pycraft. Use and Disuse and their Effect on the Bodily Structure of Animals (II.).

FREE PUBLIC LECTURES.

MONDAY, APRIL 27.

KING'S COLLEGE, at 5.30.—Prof. R Chambers: Recent Advances in the Study of Living Cells (Succeeding Lectures on April 28 and 29.)—Prof. R. Dyboski: History and Geography of the New Polish State.

WEDNESDAY, APRIL 29.

INSTITUTE OF PHYSICS (at Royal Society), at 5.30.—Dr. W. Makower: Physics in the Rubber Industry, with special reference to Tyre Manufacture.

THURSDAY, APRIL 30.

KING'S COLLEGE, at 6.30.—Dr. O. Vočadlo: The Czechoslovak Republic To-day: Geography of the State.

FRIDAY, MAY 1.

UNIVERSITY COLLEGE, at 11.—Prof. A. V. Hill: The Physiology of Muscle and Nerve. (Succeeding Lectures on May 8, 15, 22.)

KING'S COLLEGE, at 5.—Dr. A. W. Rogers: Physical Features of South Africa in relation to its Geological Structure and History. (Succeeding Lectures on May 8 and 15.)—At 5.30.—Prof. F. J. Cole: The History of Protozoology. (Succeeding Lecture on May 8.)



SATURDAY, MAY 2, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2896, VOL. 115]

Benefactions to Universities: British and American.

ANY attempt to apply to such matters as gifts and bequests to universities the methods of scientific investigation is beset by peculiar difficulties. To begin with, no complete tabulated statistics of such benefactions are in existence. Many of them are not in the form of money, and their money value is not easily ascertainable; public announcements of gifts of houses and lands often do not indicate their value, and bequests are often subject to indeterminate charges, or in the form of residuary estates regarding which no further public announcement is made. The figures to be given in this article have, therefore, no pretensions to exactitude. Further, if we proceed to use available data, such as they are, for purposes of comparison, inference, and prediction, it is soon apparent that the flow of benefactions is as little subject to ascertainable laws and its course as difficult to predict as if it were "the gentle rain from heaven". An illustration of this difficulty is afforded by comparing the benefactions, as recorded in the "Universities Yearbook," of the years 1913–14 and 1923–24.

The high cost of living, the crushing weight of taxation, and the general exhaustion entailed by our huge war expenditure, seemed bound to affect adversely the stream of benefactions; a stream fed from that comparatively small portion of private fortunes which is left over after the more imperative claims have been met. This margin at the free disposition of the possessor has, in too many instances, been squeezed out of existence. Nevertheless, the stream shows no signs of drying up. The tale of gifts and bequests to universities and university colleges in Great Britain and Ireland during the year 1923–24 amounts to 898,000*l.*, while the corresponding total for the last pre-War year is 292,000*l.* The former total includes, it is true, gifts from the Rockefeller Foundation of America, amounting to 243,000*l.*, but, even when these are deducted, the balance, 655,000*l.*, represents an effort far greater, presumably, than was exerted ten years ago in the same way. Two large recent gifts, one of 250,000*l.* by the Right Hon. T. R. Ferens, Lord High Steward of Hull, as a nucleus of a fund for the founding of a university college for that town, and an anonymous gift of 50,000*l.* to the Royal Technical College, Glasgow, suggest that the record of 1924–25 is not likely to show a falling off.

Substantial though these figures are, they do not bear comparison with the record of transatlantic benefactions. Last December, within one week, gifts for university purposes in the United States amounting to more than 11,000,000*l.* were announced: Mr. James B. Duke, of Charlotte, in the State of North Carolina,

created a trust fund of forty million dollars for the establishment of a university in that State, and Mr. George Eastman, founder of the Eastman Kodak Company, made gifts of eight and a half million dollars to the University of Rochester, N Y., to which he had already given many millions, four and a half millions to the Massachusetts Institute of Technology (bringing the total of his gifts to this Institute to fifteen millions), and two millions, contingent on gifts of a like total amount from others, to the Hampton Institute, the Tuskegee Institute, and other institutions for the education of negroes

The United States Bureau of Education has recently published a bulletin, No 20 of 1924, containing statistics of universities, colleges, and professional schools for the year 1921–22. These include the following particulars of benefactions total of gifts and bequests reported for the year—77 million dollars, or, say, 16,000,000*l*., number of institutions which received gifts of more than 100,000 dollars, 105, amount of such gifts, 66 million dollars The corresponding figures for the universities and university colleges of Great Britain and Ireland are, for 1923–24. total (as already stated)—898,000*l* ; number of institutions which received gifts and bequests amounting to 20,000*l*. or more, 13; amount of such gifts and bequests, 748,000*l*. It will be seen that the total is about one-eighteenth, or, deducting Rockefeller gifts, one twenty-fourth part of the American total

One may safely attribute this disparity in some measure, at any rate, to the effects of the War: the damage suffered by Britain being enormously greater than that suffered by the United States, whilst the annual payments on account of our war debt to America enormously diminish that freely disposable margin of wealth from which alone our benefactions can come, and swell *pari passu* the corresponding margin in the United States It is perhaps not too fanciful to suppose that one may discern in the recent very large gifts from the Rockefeller Foundation Trustees and other American benefactors to British universities a magnanimous effort to redress the balance. An examination of statistics for 1913–14, however, indicates that even before the War, benefactions to British universities were but a small fraction, one-fourteenth of those to American.

Tribute should here be paid to the generosity of those American benefactors who have recently founded numerous valuable fellowships tenable in the United States by British graduate students. The latest and largest of these foundations, that of the Commonwealth Fund of America, will, when fully in operation, maintain some 50 British graduate students in universities in the United States.

Statistics relating to higher education in the United States are very comprehensive. The "Universities Yearbook" of the British Empire, from which the figures given above for Great Britain and Ireland are taken, includes no returns from colleges or professional schools which are not either incorporated in or schools of the universities or in receipt of Treasury grants. Mr Simpson Gee left 20,000*l*. last year to one of these excluded colleges (Leicester), and there were no doubt other similar bequests and gifts to such institutions. Comparison with American statistics is further vitiated by the circumstance that much of the work of the colleges which send returns to the United States Bureau of Education corresponds more nearly with that of the higher forms of British public and secondary schools than with work done in our universities A better basis of comparison is obtained by dividing the total amount of benefactions by the number of students in the institutions included in the returns. This gives: for the United States in 1910 and 1920 respectively, 70 and 165 dollars per student, and for Great Britain and Ireland in 1913–14 and 1923–24, 7*l* and 12*l*.

A very large number of the gifts and bequests received by American universities, especially the private universities, come from their alumni, and not only are these much more numerous than the alumni of British universities (the number of university and college students in the United States, excluding those in preparatory departments, was 550,000 in 1921–22), but also a much larger proportion of them make their careers in commerce and industry Commenting on the attachment which links every American "college man" to his Alma Mater, Prof Caullery wrote in 1917 (in "Universities and Scientific Life in the United States"). "Its force and prevalence are one of the undeniable marks of an idealistic side in the American mentality. And of course the universities are carefully on the watch to maintain it. . . The university becomes the centre of a vast family, so much the more powerful, the more numerous it is . . . Gifts to universities have thus become a normal element of the civic activity of the wealthy class. . . ." So important and so normal a source of income have such gifts become that one of the principal functions of the president of a (private) university is, says Caullery, to "adroitly rouse the generosity of the alumni."

There are signs that as industry and commerce attract, as they are doing, more and more men from British universities, and among them, doubtless, more and more potential millionaires, this particular source of university income is likely to be more productive than it has been in the past. When, a few weeks ago, Lord Balfour, as Chancellor of the University of Edinburgh, addressed a meeting of the recently formed

Alumni Association, he pointed out, in the course of an eloquent appeal which ought to be broadcasted wherever university men are to be found, that the university "has a right to ask those who are not millionaires, especially those who in their day have profited from her services, now to aid in maintaining the provision for the successive generations that pass through her class-rooms" and, an American would add, her halls and stadia On the same occasion, Sir Harold Stiles, the first president of the Association, was able to announce a gift of 1000*l.* from one of his former pupils, now resident, by the way, in the United States

A characteristic of British as compared with American benefactions is the greater particularity with which benefactors specify the purposes to which they desire their money to be applied Of 150 benefactions in 1923–24, 83 were for the encouragement of the study of specified subjects, 25 were for scholarships or bursaries, 9 for libraries, 9 for objects connected with corporate life such as hostels, unions, and sports grounds, and 5 for scientific or industrial research.

The whole subject of the influence of philanthropy in the history of higher education in the United States has been explored recently by Associate Prof J. B Sears, of the department of education in Stanford University, California, and the results of his researches were published by the Bureau of Education in Bulletin, 1922, No 26. He directs attention to the steady increase in the benefactions for higher education during the forty years 1875–1915 from 3 million to 20 million dollars, but points out that the rate of growth of wealth of the United States was somewhat greater, and that of the *per capita* wealth far greater. Since 1915 the benefactions have increased almost fourfold It would seem that on both sides of the Atlantic the War has led to a wider recognition of the national importance of higher education, as the great increase in the number of students indicates a wider recognition of its value to the individual A belief in the value of education, alike to the nation and to the individual, has been general in the United States from their earliest times and may be traced to the character of the New England settlers. It is reflected strikingly in one of Prof. Sears's tables showing for the years 1893–1916 gifts and bequests classified under five heads: (1) educational institutions, (2) charities, (3) religious organisations, (4) museums, galleries, and public improvements, and (5) libraries. No less than 43 per cent fall under the first head. A glance at the lists of bequests in "Whitaker's Almanack" shows that to the British testator educational institutions appeal much less strongly. To this difference of prevalent sentiment and estimation of values must be due in large measure the difference in magnitude between British and American benefactions to higher education.

The Greatness of Galton.

The Life, Letters and Labours of Francis Galton. By Prof. Karl Pearson. Vol 1 · Birth 1822 to Marriage 1853. Pp. xxiv + 246 + 66 plates. Vol 2: Researches of Middle Life. Pp. xii + 425 + 54 plates. (Cambridge · At the University Press, 1914–1924) Vol 1, 30*s.* net, Vol. 2, 45*s.* net

THESE two stately volumes, which will be followed by a third, form a worthy memorial of a great man. It has been a labour of love to Prof. Karl Pearson to write them, a piety which must have cost him much, especially in the case of the second volume when the outer eye began to fail He has earned the deep gratitude of all students of science, for besides giving us a living portrait, he has brought together a readable account of all the more important, not too technical, contributions that Galton made to science The value of this is inestimable, for Galton scattered his papers widely, and many are not readily accessible

The work is a sympathetic tribute to a master and a friend, and it is a fortunate fact that such a biographer was available. No one else could have done it with anything approaching the same success The canvas is large, but every corner is significant and painted with the same loving carefulness That the artist shows himself as well as his subject is the touch of perfection. It is also fortunate that it has been possible to reproduce so many photographs which would otherwise soon have been lost The volumes are two galleries, showing us not only the development of the man and his many moods, but also his ancestry, and his own photographic experiments. The drawback is the inevitable, though marvellously moderate, expensiveness of the volumes They are so exceptional and so rich in inspiration that we venture to suggest to some benefactor that copies should be sent to the departmental libraries of the relevant laboratories in the universities and colleges of Great Britain. It would sow for a big harvest

The first volume was published about a month before the outbreak of the War, and has not received the attention that was its due. It begins with a careful and detailed account of Galton's noteworthy ancestry in many lines—an impressive study in heredity. Who, as he reads, can help feeling the value of good stock; and even if Francis Galton and Charles Darwin stand out as the pre-eminently happy combinations, they are certainly not alone in this lineage This is not the place for argufying, but the biographer provokes it a little by the prominence he gives to Darwin's opinion—it has a whole page to itself—"I am inclined to agree with Francis Galton in believing that education and environment produce only a small effect on the mind of any one, and that most of our qualities are innate."

We must confess that this does not strike us as wise. No doubt, the fundamentally important thing is good seed, and neither soil nor sunshine can change bad seed into good. Yet they count for much, and Darwin was speaking of the individual Galton was a happy blend of many very fine ancestral traits, but a good stock with fine hereditary "nature" usually secures for its progeny a generous "nurture"; and the outcome is a product of the two. We believe that psychical qualities are inherited like and along with the physical, but we do not feel at all convinced that what we call "the mind" develops altogether as "the body" does The biographer admits that there was a period when Galton's fate seemed to hang in the balance. He might have subsided into a country gentleman, famous for his geniality and shrewdness, introducing ingenious devices in agriculture, probably a member for the county, possibly a M.F H We cannot produce any statistics, but experience suggests that the nurture of the innate qualities tipped the balance in the favour of science

The story of Galton's school years makes one ashamed. Certainly this part of his nurture counted for little. "Anxious and willing to learn, he was given stones instead of the bread that he hungered for, and thus his chief school years were years of stagnation." Then came some stimulating holiday travel, a little medical education when he was 16 and 17 years of age, a journey down the Danube to Smyrna, and three years of mathematical education at Cambridge, which did not suit him particularly well and ended in over-strain and breakdown So ended his apprenticeship, not too brilliantly. Of the "journeyman" years, 1844–1849, there is very little record, but there must have been much ferment and change. He deserted medicine and drifted from orthodoxy towards agnosticism, he visited Egypt and Syria; a chance meeting with a distinguished French exile, Arnaud Bey, had important consequences in suggesting scientific motives for Galton's future wanderings. But the shaping influences of this period are vague and the case for nurture is weak. Somehow, we know not how, Francis Galton grew into a purposeful man with re-awakened scientific interests. In 1853, at the age of thirty-one, he married Miss Louisa Butler, daughter of the Dean of Peterborough, and this calmly happy union lasted for forty-three years.

The second volume takes up the tale when Francis Galton was thirty-two, married, leisured, disciplined, much-travelled. "His experience had been such that he knew more of mathematics and physics than nine biologists out of ten, more of biology than nineteen mathematicians out of twenty, and more of pathology and physiology than forty-nine out of fifty of the biologists and mathematicians of his day." There was always catholicity in his scientific interests, but his central enthusiasm was still for geography. This was the period of his "Art of Travel" (1855), with its wealth of practical ingenuity and penetrating insight, his attempts to lessen some of the gratuitous tragedies of the Crimean War, his secretaryship of the Royal Geographical Society, his invention of the hand heliostat and how many other devices, and his climatic and meteorological studies (including the suggestion of weather-charts and the discovery of "anticyclones"). Busy as he was, he found time to start (with Spencer and Norman Lockyer) a short-lived weekly journal called the *Reader*, which indirectly led to NATURE. "Pereat Lector, Natura resurgat."

During this period also Galton showed his open-mindedness by taking some interest in spiritualistic claims. His biographer speaks forcibly of those who do not doubt that the methods used for solving the problems of the phenomenal universe are adequate as instruments of research in "the unknown vast of the hyper-phenomenal."

"Such a man of science, possibly owing to a lack of epistemological study, forgets that his senses have been developed to grasp physical phenomena, that his concepts are deductions from his sensuous perceptions, and that neither his sensuous nor mental outfits are adapted for sensating, perceiving and conceptualising the hyper-phenomenal. Some men grasp this truth by the logic of reasoning, others by the logic of experience, others by a healthy instinctive appreciation, and some never grasp it at all To the first group we may, perhaps, say Huxley belonged, to the second Galton, to the third Darwin, and to the fourth Crookes and Alfred Russel Wallace."

The centre of gravity of Galton's interests gradually shifted from man's environment to man himself. "About the time of the appearance of Darwin's 'Origin of Species' I had begun to interest myself in the Human side of Geography." We find him keenly interested in the domestication of animals, propounding the view that wild animals were tamed as pets or even kept for religious purposes before they were domesticated for food or transport. He was pondering over man's early gregariousness and he was thoroughly gripped by Darwinism. He laid the foundation-stone of his future anthropological work—the equal inheritance of psychical and physical characters—and he was profoundly moved by the ideal of the improvement of the human breed. His anticipations were remarkable; witness his grasp of the idea of the continuity of the germ-plasm, his rejection of the theory of the transmissibility of acquired characters, his emphasis on the survival value of affection, for animals as for man, his Law of Ancestral Heredity, and his investigation of heredity in twins. The biography gives us a very impressive picture, its Holbein detail contributing to reveal Galton's many-sidedness.

"Galton the Cambridge mathematician, Galton the ox-rider, Galton of the wave-machine, and Galton the eugenist, seem at first sight so widely incongruous and yet, rightly estimated, are necessary features of that all-round individuality—observant, constructive, calculating, and enthusiastic—of Galton the anthropologist, using that term in its widest sense, who by originality of method, wide experience of men and ripe judgment of affairs, influenced the development of many younger men in the last quarter of the nineteenth century."

The next period was largely occupied with the study of heredity, and the biography gives us the gist of Galton's correspondence with Alphonse de Candolle The Swiss botanist was interested in the history of men of science and was inclined to ascribe to environmental influence a larger rôle than Galton had allowed for in his "Hereditary Genius" After a certain amount of friction, the two men, who were emphasising complementary factors, became good friends and mutually inspired each other's work. The correspondence led to Galton's "English Men of Science, their Nature and Nurture" (1874) This was the period of Galton's prolonged experiments on the transfusion of blood, his criticism of Darwin's provisional hypothesis of pangenesis, and his further recession from the Lamarckian belief in the transmission of somatic modifications. There have been many great letters in NATURE, but there never was a finer than Galton's of May 4, 1871, a fresh revelation of the bigness of the man We are glad to see prominence given to Galton's very important Royal Society paper of 1872 on "Blood-relationship," which has not been adequately appreciated; but we think there should have been more recognition of Weismann's later, but independent, work (1885) which struck the elusive mark of biologists' attention, missed, we think, by Galton.

There is inspiration for us all in the masterly chapter on Galton's psychological investigations, and he must be rather easy-going, we think, who can read it without reproaching himself for not having made more of Galton's suggestiveness and "generosity of ideas." Galton was one of the first, if not absolutely the first, to insist that anthropometry cannot make real progress without psychometric observation and experiment, and Prof. Pearson definitely claims for him a pioneer position in experimental psychology in Great Britain The chapter deals with Galton's psychometric instruments, observations, and experiments, and with the conclusions reached in the "Inquiries into Human Faculty and its Development" (1883).

The possibility of some sort of communion with an indwelling divine Spirit was to Galton an almost life-long subject of thought.

"There is no subject more worthy of reverent but thorough investigation than the objective evidence for or against the existence of inspiration from an unseen world, and none that up to the present time has so tantalised the anxious and honest inquirer with unperformed promise of solution"

We do not ourselves understand how an individual can hope to find nowadays any objective evidence of an unseen world which seems to some to be spiritually discernible, but Galton struck the religious note when he spoke of the possibility of "inspiration from an unseen world." His own tendril towards the absolute was a kind of pantheism; he asks whether "our part in the universe may possibly in some distant way be analogous to that of cells in an organised body, and our personalities may be the transient but essential elements of an immortal and cosmic mind" Apparently finding little satisfaction in this, Galton concentrated on an ethical evolutionism In Prof Pearson's words, Galton's position was

"If the purpose of the Deity be manifested in the development of the universe, then the aim of man should be, with such limited powers as he may at present possess, to facilitate the divine purpose Darwin for the first time gave a real history to living forms, and Galton following him said Study that history, study the Bible of Life, and you will find your religion in it, and a new and higher morality as well Thereby he raised Darwinism on to a higher, a spiritual plane"

This is well said, but when we contrast it with, for example, the phrase "inspiration from an unseen world," we see that the religious note, unless we are to rewrite history and redefine the term, has almost ceased to sound. "A new religion based on scientific knowledge"! It seems to us a contradiction in terms, for religious activity has always meant some kind of appeal—practical, emotional, or intellectual—that man, at the end of his tethers, has made to an order of reality beyond sense and science, "hyper-phenomenal" as Prof. Pearson would say. We have said that the religious note had almost ceased to sound in Galton's ethical evolutionism, but there was just a faint resonance inasmuch as he believed that man's application of the doctrine of evolution to the betterment of the human race meant bringing himself into line with the purpose of the universe

In the closing chapter, which follows an account of Galton's photographic researches, there is an account of his many-sided statistical work. Here we find, to select one point only, a very interesting interchange of letters with Florence Nightingale, who was not only the "Lady of the Lamp," but also the "Passionate Statistician." She was full of the idea of a professorship of "Applied Statistics" and wrote to Galton on the subject. Here we may well quote Prof. Pearson again:.

"For Galton and for Florence Nightingale the end and the means were the same: men must study the obscure purpose of an unknown power—the tendency behind the universe; and the manner of our study must be statistical. Therein, according to Francis Galton, lay the way to that unsolved riddle of 'the infinite ocean of being', therein, according to Florence Nightingale, lay the cipher by which we may read 'the thoughts of God'. Men of the twentieth century may fail to appreciate the doctrine of either great Victorian, but of one thing they may be sure, the belief in both of them amounted to a religion. What was a religion to both became at once in both a motive for action."

It would indeed be a fine thing if Galton's purpose in founding a school of eugenics were continued in the establishment of a Nightingale chair of applied statistics. It is a pity that millionaires have so little imagination.

There are many impressions left after reading this biography—the versatility of the man, his generosity of ideas, his originality in blazing trails, his clearness of vision, his intensity of mental process, his magnanimity and kindliness, and his sense of citizenship. We cannot end better than by endorsing the biographer's own words:

"Of one thing we are certain, that the reader, who will follow patiently our hero through the great and the little, the apparently trivial and the apparently vital incidents of this story, cannot fail to fall in love with a nature which met life so joyously, and from childhood to extreme old age was resolved to see life at its best and be responsive to its many-sided experiences."

Colloid Chemistry.

(1) *Les colloïdes*. Par J. Duclaux. (Actualités scientifiques.) Ouvrage couronné par l'Académie des Sciences. Troisième édition, entièrement revue et augmentée. Pp. viii+290. (Paris: Gauthier-Villars et Cie, 1924.) 15 francs.

(2) *The Elements of Colloidal Chemistry*. By Prof. Herbert Freundlich. Translated by Prof. George Barger. Pp. vii+210. (London: Methuen and Co., Ltd., 1925.) 7s. 6d. net.

(3) *Colloid Chemistry: an Introduction, with some Practical Applications*. By Jerome Alexander. Second edition, revised and enlarged. Pp. viii+208. (London: Chapman and Hall, Ltd., 1925.) 9s. 6d. net.

THE reviewer confronted with three works on the same subject, written by authors belonging to three different nationalities, is almost irresistibly tempted to enlarge on national character in scientific writing. To escape this temptation he has adopted the prudent course of leaving it to the reader to decide what part racial and what part individual characteristics bear in determining the difference in treatment.

(1) The author is one of the earliest and most determined representatives of the purely chemical school, and his work is an admirably lucid and elegant attempt to present the properties of colloids from this point of view. His type substance is colloidal ferric hydroxide sol, the particles of which are complexes of n molecules of ferric hydroxide to one of ferric chloride, which is ionised and causes the positive charge. n may vary from about 25 to 800, though with $n > 400$ the sol becomes unstable. A similar "condensed" composition is postulated for other colloids, though the ionising group may be absent in those which are electrically neutral. Where this view encounters obvious difficulties, as in the sols of the noble metals, the author falls back on the impurities which are essential constituents of stable sols. He complains that many colloid chemists appear to have no use for the balance and the burette, and it is therefore curious that the work of Pauli, to whom this (not quite unjust) reproach certainly does not apply, receives no mention. More especially his work on silver sols is of fundamental importance, incidentally his careful investigations of ferric hydroxide sol lead to conclusions which differ from those of the author.

Adsorption receives critical treatment in the second half of the work, the author justly points out how much of the theoretical work has been done with so extremely ill-defined a body as charcoal, and on the whole concludes that the importance of adsorption in colloidal phenomena has been overrated. A reference to Freundlich's great "Kapillarchemie" leads up to the delightful statement, italicised in the original: "il n'y a pas de chimie capillaire distincte de la chimie ordinaire".

The author's very original views on gel structure and on hydration unfortunately do not lend themselves to a short summary, but deserve careful study.

(2) Freundlich's "Elements" follows the general plan of the larger work mentioned above. After an introductory chapter, the phenomena at the various types of interfaces are described, and only then are colloid systems discussed in some detail. Both the electric charge on particles and electrolyte coagulation are ultimately traced back to adsorption. Even the less familiar disperse systems, like foams, smokes and solid dispersions, are not omitted, and, without devoting excessive space or special chapters to "applications," the author manages to give many striking instances to show how the study of colloids is providing explanations of natural phenomena.

Prof. Barger's translation is a faithful and—apart, perhaps, from a few hyphenated adjectives—idiomatic rendering of the original. In a note, which must command the sympathy of everybody who has had to write about the subject, he suggests that "a determined

attempt" should be made to find equivalents for the German verb "quellen" and the noun and adjective derived from it The usual rendering "swelling" is certainly unsatisfactory, and the lack of an adjective and noun—though not by any means confined to this verb—leads to painful circumscriptions It is to be hoped that purists will not be too violently upset by Prof. Barger's suggested terms: turgesce, turgescible, and turgescence.

The serious student of colloids cannot do better than to study Duclaux's and Freundlich's books together. If he finally arrives at the conclusion that his attitude for the present must be that defined by the venerable motto, "Nullius in verba," he will have no reason to regret the time spent on them

(3) The plan of this book differs radically from that of either of the works just discussed Nearly three-quarters of the total space is devoted to "applications" covering pretty nearly the entire range of human activities, and falling under the three heads with which the reader of the literature of colloids must be becoming familiar problems which have been elucidated, problems which may some day be solved, and a large mass of material which is restated in a new terminology. This is not to say that these chapters do not contain many interesting things, but it is unreasonable to expect any sense of proportion in approaching them from a reader who has been provided with merely 54 pages of theory The first section of this inadequate part, curiously entitled "Material Units," wastes space on brief excursions into relativity, isotopes, the size of the electron, and other topics the bearing of which on the subject is difficult to discover Equally difficult is it to find any plan in the chapter on the general properties, which begins surprisingly with protection, and ends with half a page on viscosity. The whole book gives the impression of having been written with the intention of assisting in the very active propaganda for colloid chemistry which has for some time been carried on in the United States

One feature, which could have been noticed in about a dozen books in recent years, may conveniently be mentioned here. In his first publication on the subject, Zsigmondy gave a plate showing various microscopic objects, and gave the magnification as "1 : 10,000." This singular way of describing a *magnification* has been copied religiously with the plate by a number of authors; in the book under review the figure has, in addition, been reduced to about two-thirds of the original size. These things are probably not sufficient (as Macaulay wrote on a similar occasion) "to make one despair of the human species," but they do throw a curious light on the way in which books are made.

E. H.

Water Plants.

Biologische und morphologische Untersuchungen uber Wasser- und Sumpfgewachse Von Prof. Dr. Hugo Gluck Vierter Teil: Untergetauchte und Schwimmblattflora. Pp viii+746+8 Tafeln. (Jena Gustav Fischer, 1924) 45 gold marks.

THE extreme variability which water plants show under varying environmental conditions is well known Almost equally well known are Dr. Gluck's monumental studies on these plants, of which a further contribution is now available This fourth volume of the series deals chiefly with the submerged and floating leaved floras of Europe and the Mediterranean regions, but it also contains a supplement to the third volume, which dealt with marsh plants While reference is made to all the more important genera of water plants, the larger genera like Ranunculus, Potamogeton, and the water lilies naturally receive most attention

Dr. Gluck's method is to describe quantitatively, so far as is possible, the form variations observed either in Nature or under cultural conditions He recognises these variations as being either of genetic origin or else as due to environmental conditions Like its predecessors, this volume is noteworthy for the mass of new material recorded The treatment of variation in Nuphar and Nymphæa is exceedingly well done, including as it does descriptions of the variability of the pollen grains and carpels In dealing with other genera, the author points out that the summer leaf forms of many species are often strikingly different from those produced during winter For example, the form of *Potamogeton crispus* known as *P serratulus* Schr (=*P. serratus* Huds), with relatively narrower leaves, serrated margins, and longer internodes, has been grown in culture as the winter form of type plants. The forms found in running water often differ in a similar way from those of standing water The internodes and leaves are relatively longer in running water, according to Dr Gluck, a good example being provided in *P perfoliatus* var *lanceolatus* Blytt

It may be urged that the rôle of light intensity or of duration of exposure to light has been somewhat neglected by Dr. Gluck Many of the types described as winter forms or running water forms (as in the examples quoted) may occur in summer or in standing water if the water is sufficiently deep Some of these forms have been produced recently by culture in light of low intensity. It is probable that this factor, which would operate in water, in running water or in deep standing water, is the common feature which produces longer internodes and smaller and narrower leaves under these natural conditions. The changes are those which, in more extreme form, are produced in etiolation.

For comparative purposes, therefore, the value of the numerous tables given in this book would have been greatly enhanced if data as to the depth of the water (and hence indirectly the light intensity), in which the various forms occurred, had been always included This single criticism need not, however, prevent us from congratulating Dr Gluck on an exceedingly valuable contribution to the study of form variation and to aquatic biology.

Our Bookshelf.

Wettervorhersage die Fortschritte der synoptischen Meteorologie Von Prof. Dr. Walter Georgii. (Wissenschaftliche Forschungsberichte · Naturwissenschaftliche Reihe, Band 11) Pp viii + 114 (Dresden und Leipzig: Theodor Steinkopff, 1924) 4 50 gold marks.

THE title chosen by Dr Georgii for this work—"The Progress of Synoptic Meteorology"—is perhaps rather ambitious for a work which runs to no more than 111 pages It is largely an account of the meteorological theories of V and J. Bjerknes and of F M Exner, one might almost say of the Norwegian and Austrian schools of meteorology, but it contains also short accounts of certain lines of research not especially associated with these schools

After the first introductory chapter, which describes the construction of synoptic weather charts, there follows a summary of the views of V and J Bjerknes on the origin and structure of the cyclones of temperate latitudes, together with a short account of Exner's theory of cyclonic formation as a result of the obstruction of the circumpolar easterly winds by mountain ranges The third chapter deals with the travel of pressure and wind systems and of the weather associated with them, in other words, with the phenomena upon which the practice of synoptic forecasting rests. This discussion is in terms of the two schools of thought to which reference has already been made, the moving streams of air are regarded as more fundamental than the pressure-systems with which they are associated, a conclusion which had been reached many years ago by Sir Napier Shaw in Great Britain as a result of his investigation into the life-history of surface air currents The account of Ficker's idea of "high" and "low" cyclones and anticyclones towards the end of this third chapter is a timely reminder that no theory of cyclones and anticyclones is complete which relies on temperature differences in the troposphere for explaining the differences of pressure between these systems, for it is well known that at a height of about ten kilometres, *i e* near the top of the troposphere, variations of pressure occur at least as large as those observed on the ground, and these are potent factors in the determination of the pressure at the level of the ground. It is natural, however, that in dealing with progress in synoptic weather forecasting, greater stress should be laid on the phenomena of the lower layers, about which we have abundant information.

Meteorologists will no doubt be grateful to Dr. Georgii for condensing into so small a space material scattered in numerous separate papers in several languages, and where abbreviation has been perhaps excessive, references are always given, which enable the reader to consult those papers for fuller information.

The Synthesis of Nitrogen Ring Compounds containing a Single Hetero-Atom [*Nitrogen*]. By Cecil Hollins. Pp 423 (London: Ernest Benn, Ltd, 1924.) 55*s* net.

IT would be interesting to know how much time is annually expended in chemical laboratories in the preparation of carbon compounds, already recorded in the literature, but which their would-be discoverers believe to be new substances. The considerable waste of energy involved will, however, appear small if compared with that resulting from the choice of the less suitable methods of attack of a defined problem in organic synthesis. It cannot be said that existing safeguards, Beilstein, Richter, Stelzner, Meyer-Jacobsen, and the general indexes, are sufficient to protect us from these dangers

Elb's "Kohlenstoffverbindungen" (1889) was an early attempt to meet this need, but the basis of the work was so broad that the execution of the plan seems a prodigious task at the present time, and only possible to a Mellor of organic chemical literature Mr Hollins has chosen a section of the heterocyclic compounds, cyclic substances with one ring nitrogen member, and has produced a compilation of very considerable utility, especially to those whose investigations touch the chemistry of the derivatives of pyrrole and pyridine. The arrangement of the material is excellent, and the information which the book can give is very readily accessible The claim that the treatment is exhaustive is on the whole justified, but there are nevertheless omissions, for example, the list of *o*-nitrobenzaldehydes which have been converted into indigotins is incomplete There are also inaccuracies such as the formula for dehydracetic acid given on pp 188, 212, but neither the gaps nor the mistakes are so numerous as to detract seriously from the value of the book. The analogies which the author perceives as existing between certain synthetical methods are often suggestive, but the theoretical aspect is here of subsidiary interest and, though some of the views expressed can be vigorously contested, it is not an important criticism that the work is scarcely adequate as a treatise on reaction mechanism Not only the author but also the publishers are to be congratulated on an enterprise unusual in English organic chemical literature.

R. ROBINSON.

League of Nations: Committee on Intellectual Co-operation. Index Bibliographicus: International Catalogue of Sources of Current Bibliographical Information (Periodicals and Institutions). Arranged and edited by Marcel Godet. Pp. xvi + 233. (London: Constable and Co., Ltd., 1925.) 4*s*. net.

THE work before us is an International Directory of current periodical publications and card-indexing institutions which profess to keep their clients abreast of current progress in their respective branches by means of abstracts of papers, book reviews, or book lists. The work has been clearly conceived, and the material collected is well arranged, edited, and printed. Entries are numbered and classified by the Dewey

system, then rearranged by country of origin, and finally indexed alphabetically by titles.

A weak point in the past in all international ventures has been the inadequate central control. Here M. Godet deserves our commiseration rather than our censure. In his preface he shows that he has striven to infuse into his contributors his spirit of enthusiasm for international service. Nevertheless, he has failed—notably, we regret to say, in the case of the British contingent. Omissions we expected to find, but not omissions of the principal national sources of reference. Indeed, in many broad highways of literature, *e.g.* history, theology, education, law, geology, etc., we have failed to find a single British publication recorded. The following list of omissions will be sufficient to justify our criticism: as will be seen, it includes a few foreign entries. Bodleian Quarterly Record, Bulletin of the John Rylands Library, Special Libraries, *New Statesman* (Digest of Parliamentary Papers), *English Historical Review*, *Geographical Review*, *International Journal of Psycho-Analysis*, *Eugenics Review*, *Lancet*, *Hermes*, Architectural Association's Journal (Analytical Digest), Geological Society's Geological Literature, Royal Horticultural Society (Analytical Digest), Jahrbuch der Radioaktivität, *Science Progress*, *The Analyst*, *Zeitschrift fur analytische Chemie*, *Zeitschrift fur anorganische Chemie*, and the Zoological Society's Record. The list could be extended if space allowed. An exception to our remarks, however, should be made in the case of the British contributor to the Useful Arts. This section is fairly well covered.

North Star Navigation. By L. M. Berkeley. Pp. 86. (New York: The White Book and Supply Co., 1924.) 3.75 dollars.

It may be taken as an axiom in practical navigation that, so far at least as the northern hemisphere is concerned, no pair of observations can be depended upon to furnish with greater readiness and simplicity the true position of a ship than an altitude of Polaris—the Pole-star—in combination with that of some other star, observed about the same time on a reasonably large azimuth, and preferably in the neighbourhood of the prime vertical.

This is the problem dealt with in Mr. Berkeley's volume upon somewhat novel lines. The general practice is to reduce the altitude of Polaris to meridian by one or other of the numerous tables supplied for that purpose in the almanacs and collections of nautical tables, thus obtaining the latitude at once by simple inspection; while the zenith distance of the second star, that is, the complement of the altitude, forms the third side of a triangle in which the polar distance of the star, and the co-latitude, obtained as above, represent the other two sides. From these three sides the hour angle of the star can be calculated by the ordinary formulæ of spherical trigonometry, whence ship mean time and longitude easily follow.

The author of "North Star Navigation" employs methods of his own which, as compared with the procedure described above, can scarcely be said to gain anything in brevity or simplicity. Moreover, several special tables are required in the process proposed, two of which would appear to need recalculation year by year. The mathematical basis of the methods, however, is stated in the volume in minute detail, and will perhaps arouse interest amongst astronomers and mathematicians, but it is scarcely likely that any great number of practical navigators will be tempted to exchange their old lamps for the new ones here set before them.

Fundamentals of Bio-chemistry in relation to Human Physiology. By T. R. Parsons. Second edition. Pp. xii + 295. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1924.) 10*s.* 6*d.* net.

The appearance of a second edition of this little work eighteen months after the first is itself a good recommendation, and this favourable impression is confirmed on closer acquaintance. It fills a definite gap in biochemical literature as a short, readable, and up-to-date account of the theoretical aspect of the subject as distinct from the practical. The chief additions made to this edition are a short account of the preparation and properties of insulin and a section on Werner's views of the constitution of urea. No criticism can be levelled at the subject matter or its presentation, which is admirable as a short introduction to the subject of biochemistry. Apart from a few typographical errors, there are one or two other lapses to be noted. thus the phrase "the excitation passes from muscle to nerve" is not particularly happy, whilst insulin is *not* administered "in the form of repeated *intravenous* injections" (the italics are ours), nor is the method of standardising insulin mentioned likely to prove satisfactory. These faults detract but little from the general high level of the book. The subject matter includes chapters on the chemistry, digestion, and metabolism of the foodstuffs, on physical chemistry, including the activity of enzymes, and on the respiratory gases.

Mélanges de mathématiques et de physique. Par Émile Picard. Pp. v + 366. (Paris: Gauthier-Villars et Cie, 1924.) 25 francs.

This is a very miscellaneous volume. There are some obituary notices and discourses on anniversaries, an essay or two from reviews and reports, a chapter of a book; and two original papers. Everything that M. Picard writes is worth reading, but here he is usually reproducing arguments and views familiar to all who know his work. The personal articles are more distinctive; M. Picard excels in a form in which so many of his countrymen are eminent, the account of Abel's life and work is a model of concise scientific biography.

As the title indicates, the relations between mathematics and physics form the thread connecting all this very varied matter. This is not the place to discuss M. Picard's views; but so much has now been written round this theme that we wish that some acute but painstaking person would endeavour to reduce it all to order, and explain to us what is common to all writers and what is still in dispute. Perhaps the task is impossible; the question is really that of the relations between two types of mind, and may be eternally inexplicable; it may be that the views of M. Picard, or of any other, if reflected in any other mind, would cease to be his views. But unless some such co-ordination is possible, the deep learning and keen insight displayed in these discussions must be largely wasted.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Effect of the Earth's Rotation on the Velocity of Light.

PROF. MICHELSON has now relieved his Newtonian mind by carrying through his heroic experiment, reported in NATURE of April 18, p. 566. He finds, as he anticipated, that the ether around the earth is not disturbed into a whirl by the earth's rotation. This was to be expected, has seemed in fact inevitable, if the ether is the universal medium in which matter subsists as independent small atomic structures, each with its field of main activity purely local, in the manner vividly illustrated in less abstract days by the vortex atoms of Lord Kelvin. Like the aberration of light, the effect under notice is of the first order (v/c), and so is conspicuous far above the very refined modern relativity so called, which is founded on second order (v^2/c^2) experiments and theory.

To those who still cherish the belief, as above expressed, that the result arises naturally from actual rotation of the earth relative to the surrounding ether, and so are not reduced to ascribing it to occult mutual influence of the universe as a whole (for the effect revealed, whether it is called rotation of the earth or not, must be relative to something other than a surrounding vacuity), a main interest of this *tour de force* will perhaps lie in a different direction. The astronomical aberration of light was discovered and elucidated by Bradley, while Newton was still living, on a basis which required the ether to be stagnant—or at most to move irrotationally near the earth as Stokes indicated. Until recently, perhaps still, this criterion has remained uncertain to about one-fifth of one per cent., for the constant of aberration remained unsettled, and so might be a varying quantity, within that degree. Prof. Michelson and Prof. Gale seem to have here missed, not very widely, a full decision on this fundamental astronomical datum by a single purely terrestrial experiment, for their margin of uncertainty as now announced appears to be only twelve times that of the most refined determinations of astronomy. (Some of the recorded deviations from the mean are, however, large, with preponderance in one direction, so as to suggest weighting which would improve the result.)

The finite velocity of light, after resting for two centuries on indirect, but of course adequate, celestial evidence, was brought down to earth by direct measures by Fizeau, Foucault, Newcomb, and Michelson. It seems noteworthy that the present experiment has just missed, by no great margin, fixing the distance of the sun, the base line of astronomy, by measurements purely optical, free from need of confirmation by other determinations whether directly parallactic or indirect results of gravitational astronomy.

JOSEPH LARMOR.

Cambridge, April 19.

THE experiments of Profs. Michelson and Gale, described in NATURE of April 18, are of such fundamental consequence that it is important to express their physical implications in the simplest possible way.

Prof. Michelson's original mathematical discussion of the experiment (*Phil. Mag.* 8 (1904), p. 716) appears to be inadequate; it wrongly supposes the path of a ray of light relative to rotating axes to be a straight line. The essential features of the problem are all reproduced if the ray of light is imagined, instead of describing a rectangle as in the actual experiment, to describe a circle, or rather a many-sided polygon inscribed in a circle. Let a be the radius and A the area of this circle. To a first approximation, the time required for a beam of light to get round the circle in either direction is $2\pi a/c$, where c is the standard velocity of light. On account of the earth's rotation, the material circle rotates in space with an angular velocity $\omega \sin\theta$. Thus while the beams of light are moving once round the circle, the mirror which constitutes both starting-point and winning-post moves round the circle a distance $2\pi a^2\omega \sin\theta/c$ to meet the ray which is travelling in the clockwise direction, thereby lengthening the course for the anti-clockwise ray by an equal amount. The difference of path for the two rays is accordingly twice this amount, or $4A\omega \sin\theta/c$, and this formula can be shown to be equally valid for the rectangular path of the actual experiment.

If the velocity of each ray in space is precisely c, the phase-difference between the two rays (in complete fringes) will be

$$\Delta = \frac{4A\omega \sin\theta}{\lambda c},$$

which is the formula used by Michelson and Gale, and verified by their experiments. If the two velocities are equal to one another, although not precisely equal to c, the formula holds as an approximation. If the velocities are unequal, the formula fails.

Freed of all hypotheses about the ether, the experiments appear to show that the velocity of light in space is the same (to within one part in 10^{11}) whether the light travels in the direction of the earth's rotation or in the contrary direction. This is in accordance with the theory of relativity. Thus the experiments do not affect the position of this theory, although a contrary result would have destroyed the theory. The experiments show either that there is no ether or else that, if there is an ether, the earth does not drag this ether into motion by its rotation.

The original Michelson-Morley experiment admits of three separate interpretations: (*a*) there is no ether; (*b*) there is an ether which accompanies the earth in its motion; (*c*) there is an ether which is at rest in space, bodies moving through it undergoing contraction in accordance with the Lorentz-Fitzgerald formula. The present experiments dispose of interpretation (*b*), which, however, is generally supposed to be adequately disposed of already by the phenomenon of astronomical aberration. Interpretations (*a*) and (*c*) remain open, and the experiments do not appear to provide the means of deciding between them.

J. H. JEANS

The Dinosaur Region in Tanganyika Territory.

MR. C. W. HOBLEY'S interesting article in NATURE of April 18 (p. 573) ought to carry conviction as to the importance of the small collecting expedition which has been organised by the Trustees of the British Museum. In a short note published in this journal a year ago (March 8, 1924, p. 361) Gigantosaurus (or Tornieria), the main object of this expedition, was referred to in a manner which seems to be almost playful. The animal which is described as having "more slender limbs" than the American Diplodocus is a giant of stupendous size, possessing a humerus seven feet long, in its massiveness by no means suggestive of a creature of graceful or slender build. Without further qualification the description scarcely does justice to this wonderful animal.

Size is in fact a consideration of very practical importance. In the present instance everything must be done on a large scale—the excavation of the bones, their treatment on the spot, their transport to the coast and their freight to London. It is obvious that the work must be expensive, and I venture to hope that practical assistance will be given to the Museum, to enable it to continue and to make more complete the work already in progress The excavation of the site can be carried on, until the end of the present year at least, by means of funds in the hands of the Trustees. It can only be done, however, on a very modest scale, by restricting the number of workers, and their remuneration, to a minimum Even with this restricted programme it cannot be continued long enough to derive all the results obtainable from the bones which are lying on the surface, or close beneath it, in great profusion What variety of life is represented by the fossils is at present uncertain, but the consignment just received from Mr. W E Cutler, who is in charge, indicates that the bones are in an excellent state of preservation and that they are by no means all of one kind The extent of the Dinosaurian fauna of Africa has yet to be explored, and it must be remembered that this Continent has constantly yielded fresh surprises in animal life

The study of African dinosaurs is almost at its commencement, but we know that the material is there, ready to be picked up by any one provided with a sufficiently long purse Certain friends of the Museum have already sent generous contributions, by means of which a fund of some hundreds of pounds has been raised It is a very welcome addition to our resources, and it will materially help us to carry out the work more satisfactorily than would otherwise have been possible It falls far short, however, of our actual requirements, and I appeal for a material enlargement of the fund Contributions, large or small, may be sent to me at the Natural History Museum, marked " Tanganyika Fund "

SIDNEY F HARMER

British Museum (Natural History),
Cromwell Road, S W 5

Method of Measuring Deep Sea Tides.

IN a letter to NATURE of April 4 under this heading Prof. R W. Wood suggests the use of a subsurface buoy as an " artificial island " for supporting recording tidal gauges, in order to study the tidal rise and fall in the open sea. Many readers of NATURE are, of course, aware that a similar contrivance was worked out by Swedish oceanographers more than fifteen years ago, and has been repeatedly used with very satisfactory results, in order to take continuous records of the subsurface currents from points in the open sea off the coasts of Sweden

A large buoy of half a cubic metre capacity with a net buoyancy of some 300 kgm. is kept submerged at a depth of from five to ten metres below the surface (the depth being fixed so as not to interfere with shipping) by double anchorage, the cables diverging by about 120°. From the buoy one or two recording current meters of the Pettersson type are suspended at the desired depth, taking observations of the direction and the velocity of the current every thirtieth minute for a fortnight without recharging. As many as three such " Ekman buoys " have been used simultaneously at different localities, while the research vessel was otherwise engaged. As the point of suspension, that is, the buoy, is practically without any proper motion, the observations thus obtained are perfectly free from the errors inherent in current observations taken from ships swinging at anchor, and thus the tidal currents as well as the residual current can be computed correctly A large number of such current observations which have been taken in the course of the last few years are at present being worked up for publication

For some time it has been the intention of the Swedish hydrographers to use the same arrangement for establishing a kind of submarine hydrographic station in the open sea, the water temperature being taken by thermographs, the horizontal movements by recording current metres, and the vertical movements by means of balanced submarine floats rising and falling with the boundary of the layer in which they float, and recording its vertical movements by means of pressure-gauges, such as have already been used at our coastal stations By means of two such buoys marked with flag-staffs showing above the surface and anchored some distance apart in the open sea, a base-line can be obtained serving to define the movements of large subsurface drifters marked with small surface buoys, and thus one should be able to follow directly the movements of the water during a tidal period The rise and fall of the water level should at the same time be studied by means of recording pressure-gauges, and the currents, as usual, by our registering current meters By means of one or two such mid-sea tidal stations anchored at representative points, and supplemented by continuous observations from lightships, the intricate problems related to the tidal wave in the North Sea might be brought considerably nearer their solution This scheme, which has been on the Swedish programme for some time, can obviously be carried out only by the co-ordinated efforts of the nations interested

Regarding the use of the submerged buoy for observations over great depths, no experience has so far been gained, the greatest depths at which it has hitherto been used being about 100 metres At depths much greater than a few hundred metres, the weight of the anchors and wire-rope required would probably be a serious obstacle For particulars of the apparatus I may refer to *Svenska Hydrografisk-Biologiska Kommissionens Skrifter*, 5, and Quarterly Journal of the Royal Meteorological Society, June 1914.

HANS PETTERSSON

Oceanografiska Institutionen,
Göteborgs Högskola

An Amphoteric Substance in the Radula of the Whelk (*Buccinum undatum*).

THE experiments of J. Loeb ("Proteins and the Theory of Colloidal Behavior," New York, 1922) have shown that the iso-electric point of amphoteric substances is readily determined by staining them with basic or acidic ions or dyes at known hydrogen-ion concentrations The method has since been applied for the determination of the iso-electric point of the mycelium of Rhizopus (Robbins, W. J., 1924, *Journ Gen. Physiol.*, 6, 259) and of bacteria (Stearn, E W., and Stearn, A. E., 1924, *Journ. Bacteriol.*, 9, 463) by staining with dyes.

The radula of Buccinum appears to consist of two zones, a young newly formed part (chitin A) and an older part (chitin B) Passing along the radula, the change from chitin A to chitin B is sudden, though a small portion of chitin A persists in the base of each tooth throughout The reactions of A and B differ entirely and will be fully dealt with in a forthcoming paper by one of us (T H. R.).

Radulæ were soaked in buffer solutions of known P_H to which had been added a few drops of a solution

containing one of the following ions, Ag^+, Cu^{++}, CNS', and $Fe(CN)_6''''$ The radulæ were then washed so that the ions were only retained where they had combined with the chitin The presence of the combined ions was readily detected by the usual reagents, the silver going black on development with hydroquinone, the copper being converted into the brown ferrocyanide by $K_4Fe(CN)_6$, and the CNS' and $Fe(CN)_6''''$ giving the usual red and blue colours respectively with ferric chloride.

Since an amphoteric substance is basic on the acid side of the iso-electric point and acidic on the alkaline side, the basic copper and silver ions should combine with it only if the solution is more alkaline than the iso-electric point Conversely, the acid ions CNS' and $Fe(CN)_6''''$ will only combine with the substance on the acid side of its iso-electric point

The results of a typical experiment are shown in the table

Ion present	P_H of Solution 1 0	2 2	2 6	3 0	3 6	
Ag^+	All deep black					Chitin A
	White	Faint grey	Grey	Black	Deep black	,, B
$Fe(CN)_6''''$	All deep blue					Chitin A
	Deep blue	Blue	Pale blue	White	White	,, B

Chitin A and chitin B are seen to be very different Whereas chitin A combines with both anions and cations irrespective of the P_H, chitin B appears to be an amphoteric substance with an iso-electric point at about P_H 2 6 in a more acid solution it is basic, and combines with the ferrocyanide anion but cannot combine with the silver cation, in a more alkaline solution it is acidic, and combines with the silver cation but cannot with the ferrocyanide anion

Identical results were obtained with fresh radulæ and with those which had been previously boiled in strong potash to remove adhering tissue

From these experiments, the change undergone by chitin A on conversion into chitin B appears to be profound

C F A Pantin.
T Howard Rogers

The Marine Biological Laboratory,
The Hoe, Plymouth,
March 21

Ball Lightning Phenomena.

At dawn on the morning of the last day in 1924 there occurred in the neighbourhood of Aberystwyth, in Cardiganshire, a thunderstorm of short duration but of unusual violence, and people were alarmed at what they saw and heard News reached me that a "ball of fire" had been seen during that storm at a village called New Cross, some 4 miles south-east of Aberystwyth On hearing this I went over to interview the observers I found three at once; Mr. and Mrs. Pugh and Mr Morgan at the inn. Mr Pugh's attention was first attracted by a terrific noise On looking out his bedroom window what he saw he described as "falling lumps of fiery material" and as a "scattering of fire as from a centre" about level with the ground, and, apparently, not far from the house The house shook, and the effect was alarming. The three did not venture out for half an hour after the event At Penywern, a farm-house near by, a window pane shown to me was cracked by the explosion.

I found another observer, Mr Davies He said that whilst dressing he looked out to see what kind of weather it was, and whilst at the window saw a brilliant ball of fire at some height from the ground in a direction 30° or 40° from the horizon. The "ball" was more or less round but with luminous protuberances The direction in azimuth tallied with that of Pugh It is likely, therefore, that Davies saw the same object as was seen by Pugh but at an earlier epoch. Unfortunately Davies withdrew his gaze, involuntarily, owing to the startling brightness and strangeness of the vision and, consequently, saw no more Had he continued observing the story might have been complete.

Whilst at New Cross I was told that strange things had been seen by Mr. Edwards, of Glanrhos, four and a half miles away in direct line I proceeded there, and Mr Edwards very kindly and readily described all he had seen and experienced Many things happened on the premises, but the following is the most important Mr Edwards was in the barn when the crash happened He was thrown bodily backward but not in any way damaged On looking out he saw what appeared to be three distinct luminous masses dropping on the manure heap in the yard This was followed by a column of smoke or vapour rising from the place of impact This occurred during a shower of hail The hailstones were unusually large—half an inch or even an inch across, and of very irregular shape

In these accounts there appears to be one point of interest common to both Mr Edwards saw the luminous volumes *after* he had been thrown At the instant of being thrown he was in the act of bending to lift into a vessel some chaffed material that was lying on the floor of the barn, and had his eyes fixed on the job Similarly Mr Pugh also, he *heard the crash first* and on looking out saw the luminous objects There was an interval, therefore, between hearing and seeing in both cases which cannot be explained on the assumption that what occurred was an ordinary single electric discharge Either there must have been at least two discharges with an interval between, or something happened in a much more leisurely manner than an ordinary electric discharge Are these luminous objects likely to be identical with the ball lightning? It is not suggested in the account given that the luminous objects were solid bodies

Ben Davies

Llys Teg,
Pont-rhyd-fendigaid,
Cardiganshire

Sound Production by Insects.

Under this heading in Nature of March 21, p. 437, there was a short notice of a paper published by Dr F E Lutz in the Bulletin of the American Museum of Natural History, vol. 50, p 333, 1924. I have not been able to avail myself of the original paper, but the review brings forward several interesting points. The view expressed is: that our present knowledge does not furnish good grounds for believing that the few cases in which we hear insect sounds are exceptions to a rule, namely, that insects do not communicate by that means; that in the case of Orthoptera the presence of extreme specialisations for making sounds, accompanied by what appear to be definite ears, are grounds for thinking that here communications may be carried out by sound; but the fact that termites, *which are not known to stridulate*, have the same sort of ear as that possessed by crickets and long-horned grasshoppers, weakens the argument somewhat

I should like to direct attention to a recent paper which I published in the Trans. Ent. Soc. Lond., Parts III. and IV., p. 492, 1924, on the habits of Brazilian insects. In the course of this paper I mentioned that I had observed termite soldiers making

noises by two different means, (1) by vibrating their bodies up and down and hitting their hard "chins" against the ground (*Cornitermes similis*, Hag.), (2) by sharply crossing one mandible over the other (*Mirotermes fur*, Silv.) In some species the mandibles have even been modified for the purpose and are asymmetrical. So far as my observations went, the termites only made a noise when there was danger about, such as when I broke open their nests, and then each Cornitermes soldier would tap violently for perhaps half a minute, pause as though listening to the tappings of its neighbours, and then recommence.

Other insects, for example various beetles, will stridulate when attacked. Whether this has the effect of frightening its enemies is difficult to prove. Others again, for example various bugs, only possess functional stridulating organs in the male sex. I believe I am right when I say that some of these have been heard in action when the sexes have been placed together. In spiders a parallel state of affairs is found. I have myself made some of those which possess stridulating organs in both sexes (Avicularidæ) produce sounds by teasing them and putting them on the defensive, while the only occasion on which I have observed the other type stridulating, in which the organs are present in the male alone (Theridiidæ), is when he is in course of his courtship.

No conclusive experiments have been performed to show that spiders can hear. In the first case, where the spider is merely trying to frighten its enemies, this is not a necessary supposition, but, if the sound-producing organs are to be of any value in courtship, the female must possess some kind of ears, even if they consist merely of a few hairs which vibrate in such a way that she can recognise his presence. Are we to explain the facts to our satisfaction by a series of strange coincidences, or by admitting our inability to discover the organs of hearing in insects and spiders up to the present time?

One has got the impression that Dr. Lutz would like to explain the origin of stridulating organs by the mutational theory. Something of a Lamarckian nature would probably fit the facts more easily.

W. S. BRISTOWE.

Winnington Hall, Northwich, Cheshire,
March 23.

A Method of Determining the Frequency of a Tuning Fork.

IN an experiment performed in this laboratory on the determination of surface tensions of liquids by the method of ripples, a tuning fork, provided with a dipper and slits on the two prongs, was used to produce the ripples as well as to illuminate the surface of the liquid by intermittent light, obtained by passing a narrow beam of sunlight through these slits and reflecting it on the surface by a plain mirror. It thus became necessary to determine accurately the frequency of the tuning fork with all its encumbrances. Evidently the ordinary graphic method could not be used without introducing more complications and thus altering the frequency, and means were not available of utilising the stroboscopic method. The frequency was, therefore, determined in terms of the length, or the time of vibration, of a simple pendulum hung in front of the slits of the prongs. The light, after passing the two prong slits, passed immediately above the bob of the pendulum, illuminating a small cross which connected the bob to the suspending thread. The light ultimately fell on a drum round which could be wrapped an ordinary photographic film.

On setting the prongs and the pendulum in oscillation, and revolving the drum and at the same time moving it at right angles to the path of the light, a record was obtained on the film consisting of alternate patches of light and darkness, on which, at regular intervals, was impressed the shadow of the above-mentioned cross. The frequency of the fork could thus be determined by counting and estimating or measuring the whole and fractional number of bands between two successive impressions of the cross. In the absence of any other mechanical devices, the drum can be set in rapid revolution by the hand and moved across the path of the light, again with the hand. The fork has of course to be electrically maintained.

It may be worth while to direct attention to the fact that in all previous experiments on the determinations of surface tensions by the method of ripples, two forks have been used, one for producing the ripples and the other for illuminating the disturbed surface intermittently, the forks being driven electrically in the usual way so that the vibrations of the two were synchronous. In the present experiment, only one fork was used for producing the ripples as well as making them visible. The values obtained of the surface tensions of water and dilute salt solutions were consistent among themselves and agreed with those given in the Tables, etc. The experiment was carried out by Mr. Jai Kishen, one of my M.Sc. students of last year.

J. B. SETH.

Physics Laboratory,
Government College, Lahore,
February 26.

Change of Linkage in Poultry with Age.

Two dominant sex-linked Mendelian factors in the domestic fowl are known from the work of W. E. Agar (*Journ. Genet.*, vol. 14, pp. 265-272, 1924), J. B. S. Haldane (*Sci.*, vol. 54, p. 663, 1921), and G. S. Serebrovsky (*Amer. Nat.*, vol. 56, p. 571-572, 1922), to exhibit partial linkage during spermatogenesis, as was to be expected if both are carried by the same chromosome. One of these, B, causes barring of the feathers, the other, S, causes silver as opposed to gold hackles. We have synthesised five cocks of composition, BS/bs, *i.e.*, receiving both these factors from one parent only, and mated them with bs hens. Thus each of the four possible types of spermatozoon gave rise to a different type of chick. So far 648 chicks have been counted. We find that the linkage between B and S becomes progressively weaker with the age of the cocks. In their first, second, and third breeding years respectively these have given 22·9 ± 1·4 per cent., 36·9 ± 2·9 per cent., and 47·6 ± 3·6 per cent. of cross-overs. Thus by the third year linkage has practically disappeared.

So far C. B. Bridges (*Journ. Exp. Zool.*, vol. 19, pp. 1-19, 1915) has found a slight increase of crossing-over with age in one chromosome only of Drosophila, J. S. Huxley (*Brit. Journ. Exp. Biol.*, vol. 1, pp. 29-96, 1924) a decrease with age in Gammarus, and Castle (Castle, W. E., and Wachter, W. L., *Genetics*, vol. 9, pp. 1-12, 1924) no change in mice and rats. The variations recorded in plants may be due to temperature and other causes besides age. The change observed by us might be due to diminished rigidity of the chromosomes, increase of the forces tending to break them, or other causes. But it is of interest as pointing to pre-senile changes in the behaviour of the dividing nucleus, and as being the clearest case so far recorded in vertebrates of a change with age of the "germ-plasm" of an individual. The experiment is being continued, but will probably require another two years for completion.

J. B. S. HALDANE.
F. A. E. CREW.

The Biological Action of Light.[1]

By Prof. LEONARD HILL, F.R.S.
From the National Institute for Medical Research.

WHILE the heat spectrum, including infra-red, visible and ultra-violet rays, extends from a wave-length of some 60,000 $\mu\mu$[2] to one of 100 $\mu\mu$, beyond the outer dark heat rays are the Hertzian waves used in radio with wave-lengths extending to a thousand metres or more. The inner dark heat rays merge into the visible, which are of wave-lengths from 700 $\mu\mu$ (red) to 400 $\mu\mu$ (violet). Beyond the visible lie the invisible ultra-violet rays with wave-length from 400 $\mu\mu$ to 100 $\mu\mu$, and beyond these come the soft X-rays and then the hard X-rays and the γ rays of radium with wave-lengths so short as 0·01 $\mu\mu$.

The body of a man is surrounded with a horny layer of skin beneath which lies the living cells of the epidermis in thin layers and myriad in number. Beneath them circulates the blood through close woven networks of capillaries, in streams some 0·01 mm. thick. The epidermis reflects and scatters rays which fall upon it, but some part of the visible rays penetrate and are absorbed by the blood beneath, warming it. The dark heat rays, on the other hand, absorbed mostly by the epidermis, warm it more than the blood in the dermis. Set as windows in an almost impenetrable skin, the eyes have been evolved with extreme sensitivity to a narrow portion of the spectrum namely, the visible rays. To Hertzian waves we are insensitive; their energy has to be converted into sound and heard. Likewise we cannot feel ultra-violet, X- or γ rays; a latent period of two or three weeks follows exposure to X- or γ rays before an erythema of the skin and irritation results. A latent period also follows exposure to ultra-violet rays, but one limited to hours. While the hard X-rays and γ rays and secondary rays started by these penetrate in part to deep tissues, the active ultra-violet rays are wholly absorbed by the epidermis and exert their effect there.

Sonne found that if dark heat rays are brought to bear on the skin up to the just endurable sensation of burning, the temperature just beneath the skin will be raised to about 43° C. On the other hand, if visible rays alone are concentrated on the skin to the just bearable degree, the temperature just beneath the skin will be raised even to 47° C. This result, confirmed by Argyll Campbell and L. Hill, is due to the greater absorption of dark heat by the surface layer of the skin and a deeper penetration of the visible rays. Sonne ascribes heliotherapy to the local heating effect of the visible rays and has tried to find evidence that such local heating of the blood increases specific antibodies of the body, *e.g.* the diphtheria antitoxic content of the serum. However, P. Hartley has reinvestigated this matter with great refinement and accuracy of method, both in regard to the diphtheria antitoxin content of the serum and the agglutinin content of the serum against *B. typhosus*, and finds that light baths have not the least effect on such a specific immunity. The baths have power, on the other hand, to increase the general resistance of the body to infection, as was shown by L. Colebrook, A. Eidinow, and L. Hill, who found that a light bath intense enough to produce erythema put up the hæmo-bactericidal power of the blood as tested *in vitro*. Blood which before the bath killed say 80 per cent. of staphylococci mixed with it, two hours after a light bath killed 100 per cent. Such an effect followed no less when a *lasting* erythema was produced by exposure to heat or a mustard poultice.

In the case of the light bath the relative activity of visible and ultra-violet rays is proved in the following way. If an arclight with "white flame" carbon poles (direct current and about 2500 kilowatts) is focussed sharply through a quartz lens on to the arm, an unendurable burning sensation results almost at once. If the arm is immersed in a quartz vessel full of cold water and the experiment is repeated, no burning sensation results, but if the exposure is continued for five minutes, erythema develops some hours later at the exposed spot, and this may advance even to a blister, to be followed by a long, lasting, brown pigmentation. Repeating the last experiment with a quartz screen filled with 3 per cent. quinine solution interposed between the arc and the arm, all ultra-violet rays shorter than 330 $\mu\mu$ are thus cut out, as can be shown by the quartz spectrograph. In this case no erythema results even after over an hour's exposure. The visible rays then, apart from their heating effects, have no effect on the skin. The ultra-violet rays, acting on the cooled skin, have, on the other hand, a profound effect.

Using a quartz spectroscope and a blackened thermopile for measuring the energy of various parts of the ultra-violet spectrum, it was found by Hausser and Vahle that the maximal power for producing erythema of the skin was with the wave-lengths 300-290 $\mu\mu$, just the region which comes through with the high sun on clear days. Little effect was given by rays 313 $\mu\mu$ and 250 $\mu\mu$. A screen of uric acid (1 in 40,000 solution) in a quartz container absorbs rays shorter than 306 $\mu\mu$ (Dhéré). The mercury vapour lamp through this screen produces no erythema even after giving six times the erythema dose for the unscreened lamp. Lines 275 and 257 $\mu\mu$ of the cadmium spark spectrum produce erythema, but not line 232 $\mu\mu$. Such short rays do not penetrate the horny skin but actively kill infusoria.[3]

How slight is the penetrating power of the ultra-violet rays is shown by interposing in place of the quinine solution a thin film of the horny layer of the skin taken off a blister, or the mesentery of a rabbit. Such a film protects the skin no less than the solution of quinine.

The active ultra-violet rays penetrate to the deeper epidermic cells but no farther. Among these cells there takes place multiplication and growth, formation of pigment and transition into the horny material which is pushed outwards by the growth of cells within. In these cells the ultra-violet rays provoke changes which we may assume are similar to those which have been photographed in living anthrax bacilli by Mr. J. E. Barnard, using a microscope with quartz lenses and a band of ultra-violet rays from the cadmium spark. Under the ordinary microscope they have been observed

[1] Substance of two lectures given at the Royal Institution on March 12 and 19.

[2] $\mu\mu$ = 0·000001 mm.

[3] I am indebted to Messrs. J. E. Barnard and J. Smiles for the use of the spark.

by A. Eidinow and L. Hill on infusoria. An increasing aggregation of particles takes place in the bioplasm; in the case of infusoria this leads to cessation of movement, death, rupture, and setting free of the particles. So, too, the surface film of egg white exposed in a quartz chamber is coagulated by ultra-violet rays. Positive particles are dispersed and negative ones aggregated (Clark).

These rays displace electrons in atoms according to present physical theory and so alter the charge of the particles, some of which are to be seen in bioplasm by dark ground illumination and high microscopic magnification in active Brownian movement. This leads to aggregation started by the displacement of electrons in the atoms. Chemical change in molecular structure ensuing in the epidermal cells after a latent period, reaches such an irritative nature as to lead to dilatation of the subcutaneous blood vessels, exudation of lymph, increase of lymphocytes, and rise in the hæmobactericidal power of the blood. In cases of rickets the abnormally low inorganic phosphorus content of the blood which is significant of this condition is put up also in a striking way. Subsequent to these reactions there results desquamation, due to death of some epidermal cells followed by pigmentation. The pigment melanin is laid down as granules in that layer of living cells which lies close underneath the horny layer. Melanin is stated to be formed by the action of an oxydase in the deeper epidermic cells, as may be seen in the fresh sections of skin (cut frozen) when radiated and wet with a solution of dioxyphenylalanin; this substance is said to be the specific precursor (Bloch). The closely allied compound, tyrosin, is said to diminish in amount in the blood at the time when melanin is being formed in the skin after a light bath.

Ultra-violet rays act more quickly on warm than on cold skin. Tested on infusoria the coefficient for temperature (for a rise from 10° C. to 20° C.) is about 2-3 (A. Eidinow and L. Hill); for the frog's mesentery it is less, about 1-2 (Argyll Campbell and L. Hill). While heat of the sun may aggravate a sun burn, it is not a necessary adjuvant. Ultra-violet radiation can intensely burn the cooled skin, it is well known that glacier sun-burns may be very severe. Dewar killed microbes with ultra-violet rays at the temperature of liquid air.

The power behind the sun was worshipped by the heretic pharaoh, Akhnaton, and modern science leads us back to veneration of this power. The imagination tries to think of the infinitely intricate energy complex which goes to form a living cell, of electrons being displaced in atoms by ultra-violet rays, of molecular movement enhanced by heat rays, of radiation provoking reactions which manifest themselves as life, of the spirit of man ensuing in the evolution of energy transformations.

The law holds that absorption of rays precedes action. Rays which pass through a cell have no action upon it at all. The skin screens itself from excessive light by its horny layer and by pigment. Pigment by absorbing visible and ultra-violet rays screens the deeper cells and blood. It absorbs dark heat rays and converts visible rays into heat, and this heat, stimulating the nerve endings in the skin, may reflexly lessen body heat production while provoking sweating and dilatation of cutaneous blood vessels.

Melanin is a screen, not a sensitiser, transforming light into heat. It is present in a fine particulate form and scatters and diffusely reflects rays. The spectrograph shows that melanin in fine suspension and thin layers screens off and greatly weakens but does not wholly absorb the ultra-violet spectrum. This is in sharp contrast to a 3 per cent. solution of quinine which in an equally thin layer wholly absorbs rays shorter than 330 $\mu\mu$. A layer of sweat wetting the skin helps to reflect light, while a layer of evaporating moisture surrounding the skin helps to absorb heat rays. The pigmented naked body with sweating skin is thus favourable to the cooling of the native in the tropics, while clothing retards heat loss of the white man.

By local concentration of an arc light on a rabbit's head, it is easy to heat its fur up to 150° F. and its brain even to 107° F. while with the body in the shade the rectum is only 101° F. (Argyll Campbell and L. Hill). Pith helmets prevent local heating of the head and sunstroke in the tropics. There is rarely any danger of sunstroke in Great Britain. The sun is powerful enough only on few summer days, and bare heads offer no risks except on these rare occasions. Heatstroke from overheating of the whole body due to exhaustion of sweating in warm stagnant air is much more common—overclothed as we are for withstanding hot weather.

Downes and Blunt (1877) proved that the bactericidal action of light was due to ultra-violet rays, and much has been made of this. It has been claimed recently by Wiesner that the infra-red rays apart from their heating effect, have a bactericidal action, but this is not so (A. Eidinow and L. Hill). The only rays which kill, apart from any lethal heating effect, are the ultra-violet rays. The bactericidal power of these rays is not nearly so important as has been thought, for the rays can only kill the surface bacteria. They cannot penetrate into filth any more than through the epidermis. In their curative effect on lupus these rays act, not by directly killing the bacilli, but by increasing the unmunising powers of the tissues. This is so, even when the rays are focussed as in the local Finsen light treatment. Nodules so treated, when injected into guinea-pigs produce tuberculosis.

Mr. J. E. Barnard, by photographs taken with ultra-violet rays and a quartz-lensed microscope, has shown structures hitherto unrevealed in living yeasts, bacteria, and blood cells. This is due to the selective absorption by the outer membrane, the nucleus, and certain other granules in the cells. Infusoria vary in their susceptibility to the lethal effect of ultra-violet rays, and this probably bears a relation to the age, nutritional state, and absorptive particles within them. The lethal power on cells increases with shortening of the ultra-violet rays; for example, using the cadmium spark, a 20-minute exposure sufficed to kill infusoria placed in the 275 $\mu\mu$ band, and a 3-minute exposure in the 232 $\mu\mu$ band. The penetration of the shorter rays, however, is far less, and these, therefore, have no action on the skin. Thus, as stated above, while bands 275 and 257 $\mu\mu$ of the cadmium spark produce erythema of the skin, the intense 232 $\mu\mu$ band has no effect.

In the case of the very short rays, Mr. J. E. Barnard finds one anthrax bacillus screens another lying beneath it. With rays of weak intensity, processes of repair may keep pace with injury, and no effect be produced in living cells. A screen which allows ultra-violet rays to pass so as to give an excellent spectrum, as photo-

graphically recorded by means of the quartz spectrograph, may be found to reduce biological action very greatly, as is shown when the lethal power of the screened rays is tested against that of the unscreened on infusoria or the skin. The photographic method is so exceedingly sensitive that deductions cannot safely be drawn from it alone.

It is claimed that immunity is set up in the epidermis by one exposure to a subsequent one, and this long before pigment is formed (Perthes). Thus if an area of the skin be exposed for five minutes and again for five minutes some hours later, and a second area be given 10 minutes exposure all at one time, the erythema will be much more marked in the second area. Choosing a small dose, a second one given a few hours later increases erythema and soreness Maximal erythema, of course, cannot be further increased by a second dose, but this seems to be true for soreness also. The immunity is no doubt due to coagulation of the outer layer of living cells, whence comes peeling When pigmentation is still well marked weeks after an exposure. susceptibility of the epidermis may be shown to have returned by the erythema following a further dose of ultra-violet rays

To measure the therapeutic action of the ultra-violet rays we can use the lethal dose for infusoria contained in a quartz cell at 15-20° C , or the erythema-producing dose for the skin of the average white arm, or the rate of bleaching of a standard solution of acetone and methylene blue The last has been standardised against the two former, and each degree on the scale is twice to four times that required to produce a moderate erythema (A Webster, L Hill, and A. Eidinow.) The acetone blue solution is exposed in a quartz tube of standard diameter, and after exposure the degree of bleaching determined by comparison with a set of blue tubes of depths of tint 10 to 3. The acetone solution absorbs the ultra-violet rays shorter than 360 $\mu\mu$, and the chemical reaction set up in it bleaches the blue. Observations have been taken daily with full exposure to sun and sky at various places and show the intensity of ultra-violet radiation in clean air and the effect of smoke and pollution During a fine summer day the quartz tube may have to be changed two or three times in the day, and the highest total reading last summer at Peppard, Oxon, equalled 23. In the Alps a reading of 41 was obtained in one day In dull cloudy weather of winter the reading may be 1 or 2 and in smoke polluted towns o

Using in addition a clock to keep moving the quartz tube together with a small screen to shade it from the sun but not from the sky except that immediately round the sun, we have found that the total ultra-violet radiation from the sky is far more than from the direct sun. Dorno at Davos showed that this was so using a cadmium photo-electric cell for recording the ultra-violet radiation. Even with the sun at its zenith, the ultra-violet radiation from it is only about 90 per cent. of that from the blue sky. With the low sun, the sky yields far the more.

Smoke pollution robs us of half or more of the ultra-violet rays While seeking to abolish this evil, we require to make the loss good by the use of artificial sunlight baths Screened as he is by window-glass, clothes, fog, and smoke, the citizen is cut off from ultra-violet rays almost wholly in winter, and in consequence his general health and resistance to disease goes down. The evil is enhanced by indoor life spent in heated stagnant air of rooms, and by lack of open air, exercise, and by a diet deficient in vitamins. Thus the resistance to catarrhal infections, which spread in the crowded stagnant air of rooms, is lowered. Those who live open-air lives and are well fed, exposed however much they are to weather, are far less often attacked.

It has already been stated that the hæmobactericidal power of the blood (as tested *in vitro*) is put up in an animal by an exposure to ultra-violet radiation which is sufficient to produce erythema. It has also been found by A. Eidinow that if a little blood is withdrawn from an animal, irradiated by rotation in a quartz flask, and then put back again into the animal, this puts up the hæmobactericidal power, and yet the irradiated blood itself has this power actually destroyed in itself by radiation. The hæmobactericidal power depends on the corpuscles and not on the serum. In man it is naturally high, and can be put up less than in such animals as rabbits and pigs. It is known that ferments, serums, agglutinins, and the anaphylactic power of blood are alike destroyed by ultra-violet radiation.

Recent research on rickets has shown that the diseased calcification of the growing bones results from a diet deficient in antirachitic substance and lack of ultra-violet rays. If young rats are put on a diet deficient in antirachitic substance and having a minimum of salts of phosphorus, the latter is not absorbed from the gut. Either the addition of antirachitic substance in cod-liver oil or ultra-violet radiation for a few minutes a day will wholly stop rickets developing and cause a minimal amount of phosphorus in the diet to be absorbed and utilised in bone building (A. Webster). It has been proved that the antirachitic substance present in cod-liver oil is not vitamin A, and that it can be put into an inactive food by ultra-violet radiation (Hess, Steenbock) Thus, inactive linseed oil, casein, flour, and lettuce leaves can be made effective as cod-liver oil in preventing rickets, by rotating them in a quartz flask in front of the mercury vapour lamp. Water, fat, starch, sugar, mineral oil, glycerine, cannot be so activated. Oils retain their acquired antirachitic power for months. It has been claimed that "active" food substance on oxidation gives off ultra-violet rays, but this is not so. The error has arisen through the fluorescence of certain quartz screens used in the photographic tests (A. Webster). Drummond has shown that radiated cholesterol makes an extremely active antirachitic substance, and possibly in all food stuffs shown to be activated by radiation this is the activated body. Possibly radiated rats absorb this from the skin.

We have no evidence so far that radiation can endow an inactive food with the growth qualities pertaining to vitamin A. If this prove possible, the margarine makers will have found a fresh source of fortune in being able to claim that their product is made equal to butter. Rickets can be prevented by making the diet more adequate, *e.g.* by cod-liver oil, and also by teaching mothers the need of exposing infants' and children's bodies to the sunlight and by the use of artificial sun-baths at infant welfare centres.

Prolonged exposure to intense ultra-violet rays either of the sun or an arc light produces destruction and sloughing of the white skin. While the visible rays, beside their heating effect, have no lethal effect on the

normal living animal cell, it is easy to produce a most powerful effect from these rays by sensitisation of the cells. Many fluorescent dyes have this effect, eosin, erythrosin, etc., forming a compound with the bioplasm and so making the latter absorb and be affected by rays longer than the ultra-violet.

The most interesting sensitiser is hæmatoporphyrin, an iron-free derivative from hæmoglobin, closely allied to phyloporphyrin, a derivative of chlorophyll. Traces of porphyrin (uro- or sterco-) are present naturally in the body and may possibly give to the skin some very slight natural sensitivity to visible rays. An excess of porphyrin is present in some rare individuals endowing them with an unfortunate sensitivity which causes skin eruptions and even ulceration of extremities on exposure to bright light—a disease called hydroa æstivalis, which has to be met by the greatest care against their exposure to sunshine or bright daylight.

When the mesentery is exposed in a cool glass irrigation chamber to concentrated visible rays of an arc, no effect results, the ultra-violet rays being filtered off by the glass. Add now a trace of hæmatoporphyrin to the bath (1 in 10,000) and in a very few minutes stasis occurs in the blood vessels. The lymphocytes gather to form thrombi which block the vessels (Argyll Campbell and L Hill). While pigmented animals are protected, albinos made sensitive by injection of hæmatoporphyrin die after exposure to light. Meyer Betz was daring enough to inject some hæmatoporphyrin into himself and suffered from œdema of the face and hands on exposure to light. He remained sensitive for weeks. It seemed possible that sensitisation might prove useful in light therapy, but we have obtained no evidence of this. Animals do not stand well the exposure of the shaved skin to light after even very small doses of hæmatoporphyrin have been injected Painting patches of lupus with glycerin and eosin has been tried so as to endeavour to secure a greater local effect from light treatment, but definite evidence for this has not been found (A Eidinow and L. Hill)

Sudden exposure to ultra-violet rays stimulates to contraction such an organ as the uterus of the guinea-pig or the stomach of a frog. The excised iris by pigment is made sensitive and contracts on exposure to visible rays. Ultra-violet rays do not pass through the cornea or lens, and when the retina is damaged by over-exposure to an arc light or to sun (as in viewing an eclipse without smoked glasses) it is injured by excess of visible rays acting on its extremely sensitive substance. The specific sensitivity to different wave-lengths of the alkaline metals, sodium, potassium, etc., as shown in the photo-electric cell, is suggestive in regard to the theory of colour vision. Photo-electric effect produced by rays acting on a specific retinal substance or substances may be the first stage in the excitation of vision. Russ has claimed that the owl's eye transmits ultra-violet rays. This is not the case with the cat's eye, which has good nocturnal vision, nor with the cod's eye, a fish which swims in dim lights of somewhat deep water. Tested by putting the cornea in a band of active ultra-violet rays, using the cadmium spark, none reach a fluorescent screen placed at a window cut in the posterior part of the eye (A. Eidinow and L. Hill).

It has been suggested that there is a biological interference between infra-red, or visible rays, and ultra-violet rays. Hess found a longer daily exposure to the mercury vapour lamp necessary in order to prevent rickets in young rats (fed on a deficient diet) when a glass screen was interposed which let red and yellow rays through as well as ultra-violet, than was the case with a glass screen which only let ultra-violet rays through. The photographs of the spectra of the two screens seemed to show equality of the ultra-violet radiation, but a difference in intensity is the most probable explanation Pech claims that both bleaching of cotton and production of erythema by ultra-violet rays is delayed by a concomitant beam of infra-red rays Infusoria seemed to move actively longer in the light of a mercury vapour lamp when red rays were also thrown on them than without these rays The lethal times, however, on further trial came out to be the same in the two cases, and further research on the circulation in the mesentery and on infusoria exposed to ultra-violet bands in the cadmium spark spectrum proved negative. Not the least evidence of interference with the lethal effect was found (A. Eidinow and L Hill: Argyll Campbell and L. Hill)

Ultra-violet rays improve the growth and breeding power of fowls. Acting directly on embryos they produce monsters The loss of breeding power in man and domestic animals such as cattle is probably due largely to indoor life It has been established by abundant clinical experience that light treatment is excellent for surgical tuberculosis, rickets, and wounds (O Bernhard, Rollier, Gauvain, and others) Trials recently made on many other diseases have shown that we have in artificial sun treatment a powerful stimulant to general health and in particular of the defensive mechanism of the body against chronic infections Skin diseases such as psoriasis, ichthyosis, eczema, and boils, chronic anæmias of obscure origin, nutritional weakness and wasting in infants, chronic bronchitis and the fat flabby condition of the sedentary over-fed middle-aged person, chronic phthisis, the debility following acute infectious disease, etc., are alike greatly benefited (A. Eidinow and L. Hill; P. Hall, etc). The open-air sanatorium and school have shown how ailing feeble children can be turned into happy vigorous ones.

A very great benefit to general health can at once be secured by the installation of arc baths in schools and public baths. If in winter all children stripped but for a loin cloth, danced to music for fifteen minutes twice a week a yard or two away from and round a powerful arc lamp, *e.g.* one taking 100 volts and 30 amperes with white flame carbons, a great improvement in vigour, alertness, and health would be obtained. It is by such means that our misty, smoky, winter climate can be immediately remedied. At the same time, we can set about to secure and use smokeless fuel and clean away the hideous smoke pollution of the air. We can also set into windows and sky-lights of schools, hospitals, and nurseries the new "vitaglass," which lets the ultra-violet rays through, and use such glass for the bulbs of incandescent tungsten filament lamps, which would then be a source of ultra-violet rays of mild intensity.

Many interesting experiments are now being carried out concerning the growth of plants and fruits with and without ultra-violet rays, and on the effect of continuous lighting.

The Continents and the Origin of the Moon.

By Dr. R. H. RASTALL.

DURING the last few years there has appeared a regular flood of literature, both abstrusely technical and more or less popular, dealing with such questions as the origin and form of the earth as a whole, the stages of its history, the formation of its crust, the building of land and sea, the uprise of mountain ranges, the form and displacement of continents, the physics and mechanics of vulcanicity, and a large number of other phenomena of cosmical and geodetical nature, as well as much speculation as to the birth of the moon and its relation to the earth. These subjects have been treated from every possible point of view—astronomical, mathematical, physical, chemical, and geological. It might seem, therefore, unnecessary to add to the number of writings in this much occupied field Nevertheless, to a geologist there seem to be certain aspects of the case that have not yet been quite sufficiently co-ordinated and considered in their mutual relations Let this be the excuse for the following somewhat theoretical and speculative discussion

It is not proposed to discuss here the ultimate origin of the earth or of the solar system; for our present purpose it is immaterial whether the sun and the planets have been formed by condensation of a nebula or by accretion of planetesimals; it may now be taken as axiomatic that the earth, however formed, must have passed through a stage in which it was partly or wholly fluid This is brought out quite clearly by recent writers, such as Jeans, Eddington, and Jeffreys. The word fluid is here used advisedly, so as to avoid complications induced by the consideration of critical temperatures and pressures. This fluid mass cooled by radiation, so that at some stage a temperature gradient must have been set up, whether this gradient was regular or not is of no importance The significant point is that the physico-chemical laws of cooling of fused material become applicable. To make the matter clear, we will consider the state of affairs at the time when the first crystalline solid phase was formed at the cooling surface; the vapour phase (the primitive atmosphere) may be disregarded.

The cooling globe then constituted a complex system of many components, and the problem arises as to the number of phases which would be present under the given conditions In order to gain information on this point, several lines of evidence are available, especially the theoretical laws of physical chemistry, and the actual ascertainable facts of observation. Some of the last-named will be considered first.

It is obvious that the density of the earth's interior is about twice as great as that of the accessible crust: earthquake observations further indicate more or less abrupt changes of density at certain depths. In discussions on this point it is sometimes assumed, either explicitly or tacitly, that there are only *two* density zones, and no particular reason is usually given for any such stratification: it is taken for granted, but not explained. A short consideration may here be given to this part of the subject.

The high density of the earth as a whole (about 5·5) suggests a prevailingly metallic core, although the figure is scarcely high enough to admit of a pure metallic core, unless we assume a very thick silicate crust, to reduce the *average* density. L. H. Barnett, in a recent paper, has endeavoured to calculate the thickness of the outer crust, but his reasoning is not trustworthy, since he postulates only two zones, an assumption which is by no means proved.

At this point some purely physico-chemical considerations come in. The simple facts of metallurgical practice show that molten metal and slag possess a very limited mutual solubility, and so do sulphide and slag. Vogt has shown that at furnace temperatures the mutual solubility of slags and sulphides is of the order of 5 per cent or less, usually much less Hence a system of metal and silicate must split into two consolute liquid phases, of which the lighter will obviously float on the top of the heavier: the relations are exactly analogous to those of phenol and water. Therefore a metal-silicate earth would separate on cooling into two zones. But the visible crust of the earth contains a good deal of the sulphides and oxides of the heavy metals, which are also very insoluble both in metal and in slag

On this basis V. M. Goldschmidt regards the cooling earth as a three-phase system, with a central metallic core, an intermediate sulphide-oxide zone, and an outer silicate zone, which of course would begin to solidify first.

The observational facts of geology and the results of the detailed study of the distribution of gravity combine to show that the composition of this now solidified crust is by no means uniform, even when considered from the broadest point of view. Stated in the most general terms, the continents consist of heavier material than the floors of the ocean basins, the difference amounting roughly to something like 10 per cent. The data of historical geology also show that there are far-reaching variations in the relative levels of land and sea, as indicated by transgressions and emergences. Mainly on these grounds there has been built up the doctrine of isostasy, which regards the lighter continents as floating in the heavier material now exposed on the ocean floors; we can, if we like, visualise the position as continents of granite floating in an ocean of basalt: this generalisation is not very wide of the mark, since the known sediments form only a trifling skin, and may in reality be ignored in comparison with the total thickness of the continental blocks. From the measurable freeboard of the continents and the known relative densities, it can be calculated that the depth of the floating blocks is about 100 kilometres.

Here arises an apparent contradiction. It has just been said that there is *one* outer silicate zone in the three-phase system postulated by Goldschmidt, but the facts show *two*, an acid and a basic, or a light and a heavy zone. A good deal of work has been devoted to the study of the behaviour of silicate melts during cooling under ordinary laboratory conditions, since this has an important bearing on metallurgical practice. All authorities agree that under such conditions all fused silicates form a single homogeneous solution, and there is no evidence for separation into two consolute fractions of acid and basic composition. But the conditions of the laboratory do not tell the whole story.

It is difficult to take into account the effects of pressure, obviously an important factor, and with this is closely correlated the possible influence of volatile constituents, especially water, which is known to be abundant in natural silicate melts (magmas). It has therefore been suggested that, in the presence of water, there may be a separation into mutually insoluble liquid phases This, however, is so far pure speculation, unsupported by any experimental evidence. It is to be hoped that investigations now being carried out at the Geophysical Laboratory of the Carnegie Institution in Washington on the behaviour of silicate melts under pressure may afford some information one way or the other

However, it appears to be unnecessary to invoke any such purely hypothetical agency. From the known facts of observation and experiment it is possible to explain the existence of a differentiation of the kind required, taking place after the first appearance of a solid crystalline phase It may be taken as proved that in the case of silicates the density of the crystalline form is greater than that of the liquid, and hence crystals formed at an early stage at the surface will tend to sink Since the viscosity of fused silicate of mean composition and not far above the freezing-point is fairly high, the sinking will be slow and the crystals will be melted down again But the same high degree of viscosity will prevent ready diffusion and restoration of equilibrium , hence certain constituents, especially the heavy silicates of magnesia and iron, as well as oxides of the heavy metals, will be concentrated in the lower layers of the silicate shell, while the upper layers are relatively enriched in the light constituents, especially silica, alumina, and the alkalies, as well as in volatile elements of low density. Eventually increasing viscosity will stop this mechanical differentiation altogether, and the crust will solidify with two more or less well-marked layers As previously stated, a difference of density of only 10 per cent. is needed to account for the observed facts. Thus the outer silicate zone is differentiated into two layers, but this, with the lower zones, does not constitute a four-phase system, since the partial heterogeneity of the outer zone is due to a failure of equilibrium. This state of affairs, however, seems to be a necessary consequence of the conditions.

According to this theory, therefore, the whole of the earth's surface should be covered by a uniform shell of rock of granitic composition, having a thickness which may be estimated roughly at 100 kilometres. But it is a geographical commonplace that the continental blocks occupy only about one-third of the earth's surface, and this ratio is not materially altered if we take, as is now usual, the 100-fathom line as the true boundary between the continents and the ocean basins.

It is difficult to conceive any purely chemical or physico-chemical cause for this peculiar space-relation of the light and heavy silicate masses. Some mechanical cause is inevitably suggested, and it becomes necessary to look about for some such cause. Once more the problem may be stated in the simplest possible language, as follows: on physico-chemical grounds the earth should have a thin uniform granitic shell covering its whole surface. Actually such a shell covers only one-third of the surface: what has become of the rest?

Now the idea is by no means new that the moon has been formed by separation from the earth This has been put forward by many mathematical cosmogonists, including Sir George Darwin It has even been suggested that the vast oceanic Pacific basin represents the scar left by the departure of the moon More recently a good deal of doubt has been cast on the possibility of such an origin for the moon , one of the latest writers on the subject, however, H. Jeffreys ("The Earth," 1924), says that the separation of the moon, *if it occurred at all*, must have taken place soon after the formation of the first solid crust of the earth. The possibility is therefore not totally excluded. It is suggested here that the facts of geology and the theories of physical chemistry afford a considerable measure of support to this speculation To state the matter shortly, the suggestion here made is that the moon represents the missing two-thirds of the earth's earliest-formed granitic crust, stripped off by some form of tidal resonance, and rolled up into a ball while still more or less plastic Whether such an event is possible is obviously a subject for mathematical investigation A very similar idea has already been put forward by Prof W H. Pickering.

The purely arithmetical side of the question presents no difficulty. It is easy to calculate the thickness of crust required to be stripped off two-thirds of the earth's surface to form a globe of the size of the moon. When the calculation is made, it gives the surprisingly small result of only 41 miles or about 60 kilometres. This is less than the calculated depth of the isostatically floating continental blocks.

It is true that the present density of the moon, 3 46, is somewhat higher than that of the continental rocks, but it is probable that, at the time of the disruption, more or less of the underlying heavier material would be torn away along with the lighter portions, and there may of course have been also condensation by gravity-pressure in the moon, though this is unlikely to have been important

Not only do the existing continents cover only one-third of the earth's surface, but their distribution is also very uneven. It is well known that by far the greater part of them are concentrated within the hemisphere having N.W Europe at its centre. This concentration is so far favourable to the present theory But it is necessary to take into account the significance of the ideas as to the wanderings of continental blocks as summarised by Wegener. If this theory, which is still very much *sub judice*, be accepted, it implies that, on the whole, most of the continents were once still more concentrated into one area than they are now. It is still too early to claim Wegener's theories as evidence in confirmation of the ideas here set forth, but at any rate there is nothing antagonistic in them. It is a somewhat natural inference that a large continental block, or group of blocks, left floating after the disruption in a viscous substratum, and obviously in a state of imperfect equilibrium, would tend to drift about. But the disruption must have happened at an early stage, while the movements postulated by Wegener belong to a comparatively late stage of geological history and are supposed to be even now in progress. Still, if we accept the doctrine of isostatic flotation at all, as most writers now appear to do, the continental blocks can obviously rise and sink, so they

may just as well be supposed capable of moving sideways also.

It may be noted that the formation of the moon by the segregation of a portion of the earth's crust bears a close analogy to the formation of planets from the sun by near approach of another star, as now held by many recent writers. If the aggregation to a spherical form is possible in the case just mentioned, it should be equally possible in the case of a crustal mass stripped off by tidal resonance; it is even conceivable that the disruption of the earth may have been caused by a similar cosmical disturbance due to the approach of some other body, but as to this there appears to be no evidence, and the tidal resonance theory offers the simplest explanation.

The following short bibliography includes a few of the more important recent publications bearing on this subject:

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Obituary.

SIR RICKMAN JOHN GODLEE, BART.

BY the sudden death of Sir Rickman Godlee on April 20, science loses a singularly open-minded man of varied gifts and wide interests, who was intimately associated with the great revolution in surgery accomplished by his famous uncle, Lord Lister. In fact, Godlee is now most widely known as the author of Lister's biography, which is not only a worthy record of one of the greatest incidents in the history of science, but also a graphic picture of the simple, homely society in which the sterling characters of Lister and of Godlee himself were moulded. During his long career Sir Rickman played many parts, as senior demonstrator of anatomy and afterwards professor of clinical surgery at University College, London, and honorary surgeon at University College Hospital, as president of the Royal College of Surgeons, as surgeon to the household of Queen Victoria, and surgeon-in-ordinary to King Edward VII. and King George V.

As an anatomist Godlee displayed exceptional skill in dissection, and in addition he was a superb draughtsman. These gifts were displayed not only in his contributions to "Quain's Elements of Anatomy," but also in his own "Atlas of Human Anatomy" (1880). But perhaps his chief contribution to anatomy was his investigation of cranio-cerebral topography, which his pioneer work in cerebral surgery impelled him to undertake.

At the Hospital for Epilepsy and Paralysis (then in Portland Terrace, overlooking Regent's Park) Godlee performed the hitherto unprecedented operation (in England) of removing a tumour from the brain, after its position had been determined on the evidence provided by Sir David Ferrier's experiments on animals. This milestone in the history of surgery was made more conspicuous still when particular attention was directed to it in the *Times* of December 16, 1884, for the purpose of rebutting Ruskin's attack on vivisection.

Godlee's interest in University College and its anatomy department was maintained with unabated vigour until the end. His loss will be particularly felt this year, not merely for personal reasons, but also because his intimate knowledge of the College and of University College Hospital and his rare literary gifts were being devoted to the preparation of the history to celebrate the centenary next year.

In spite of his seventy-six years, Sir Rickman had retained his mental and physical vigour unimpaired. After his retirement from surgical practice in 1920 he was free (at his beautiful home at Whitchurch, near Pangbourne) to devote himself with new zeal to those interests in Nature—geological, botanical, and zoological—concerning which his knowledge was amazingly wide and exact. Nor did he allow these interests to affect his devotion to art. An exceptionally gifted draughtsman himself, he was keenly interested in etchings and engravings, of which he had a characteristically critical but appreciative knowledge.

Frankly outspoken and always open-minded, Sir Rickman Godlee's opinions and advice were much valued by his friends.

SIR D. GOLDSMID-STERN-SALOMONS.

SIR D. GOLDSMID-STERN-SALOMONS, better known perhaps by his earlier name of Sir David Salomons, died at his residence at Broomhill, Tunbridge Wells, on April 19, at the age of seventy-three. He was educated at University College, London, and Gonville and Caius College, Cambridge, where he graduated in the Natural Science Tripos of 1873. His uncle was Sir David Salomons, who made a long fight for admission to the House of Commons and was the first of the Jewish faith to sit there. His uncle warmly encouraged Sir David's interest in physics and engineering. He equipped a physical laboratory for him, and a few years later a workshop and a small electric generating station were added to it. Sir David was undoubtedly one of the earliest pioneers of electric lighting for use indoors. He claimed that so far back as 1874 he used incandescent lamps for house lighting. He was a most enthusiastic inventor, making for himself all the electric switches and other devices which he required. He was one of the first to realise the difficulties in the way of heating and sparking that had to be overcome. No one outside the electrical profession realises the immense amount of research and ingenuity that has been

expended in developing the ordinary domestic electric switch.

Sir David took a great interest in the development of engineering in France. He was one of the eight founders of the Aero Club de France, and was a founder and an honorary member of the Automobile Club de France. In the early days, long before there seemed to be any commercial possibilities in automobiles, he had a motor car, and later on he helped the industry by assisting in the formation of the Royal Automobile Club, of which he was a vice-president He was the author of several books, of which the best known is "Electric Light Installations and the Management of Accumulators," which is now in its eleventh edition. For many years this was practically the only book on the subject. and was in the library of almost every electrical engineer He also carried out important researches, and made inventions in connexion with electric signalling apparatus, speed indicators and fireproofing material

As a member of council Salomons took a great interest in the management of the Institution of Electrical Engineers, with which he was closely connected almost from its inception. He was honorary treasurer for many years, and a vice-president for five years In 1895 he would, in the ordinary course of affairs, have become president had not several members of council objected. They said that the president of a professional institution should only be a member who was in actual practice He was president of the Electrical Trades Benevolent Institution, and took a great interest in its prosperity He was also very interested in the training of young engineers, and founded several valuable scholarships. In his later years he devoted much time to photographic developments. His only son lost his life by drowning in 1915 when on active service.

Sir David was a good citizen and took a leading part in municipal, political and social affairs He will be sadly missed by the older generation of electrical engineers, who will always remember his useful pioneering work. A. R

WE regret to announce the following deaths

Dr. V Ebner, Ritter v Rofenstein, professor (1888–1913), and emeritus professor of histology in the University of Vienna, and a member of the Vienna Academy of Sciences, distinguished for his contributions to embryology and histology, on March 21, aged eighty-three

Dr G S. Fullerton, formerly professor of philosophy in the University of Pennsylvania and in Columbia University, and president in 1895 of the American Psychological Society, on March 23, aged sixty-five

Dr. W H Julius, professor of experimental physics since 1896 in the University of Utrecht, and known for his work in astrophysics on anomalous dispersion, on April 15, aged sixty-four

Dr Frédéric Morin, president of the Station Climatérique de Leysin, Switzerland, and one of the founders and later a president of the International Union against Tuberculosis, aged seventy-two

Mr J A. Parkhurst, for twenty-five years on the staff of the Yerkes Observatory, and associate professor of astronomy in the University of Chicago, who made contributions to our knowledge of photographic and visual stellar magnitudes, on March 1, aged sixty-three

Prof Eduard F L. Mazelle, formerly Director of the Observatory Trieste, a corresponding member of the Vienna Academy of Sciences, distinguished for his work on meteorology and seismology, on January 26, aged sixty-two

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Current Topics and Events.

MONDAY next, May 4, will be the centenary of the birth of Thomas Henry Huxley, and the event is one to be held in grateful recollection by all who esteem the pursuit of scientific truth or see the light to which it leads As a tribute to the memory of this great naturalist and teacher, we are issuing with next week's NATURE a special Supplement containing a remarkable collection of articles surveying his scientific work from various aspects and relating the personal reminiscences of the few remaining people who were in close contact with him during his life It is very rarely that a great man of science is also a great leader in social and intellectual development, but in Huxley these two qualities were brilliantly combined. The four volumes of his scientific memoirs establish his place in scientific history, and the papers in them display deep insight as well as extraordinary powers of generalisation. As examples of his scientific genius mention may be made of his recognition of the fundamental character of the endoderm and ectoderm, his demonstration of the close affinities between reptiles and birds, and of the ancestry of the horse, and his work "On Man's Place in Nature," in which he showed that the anatomical differences between man and the higher apes were no greater than those between the higher and lower apes, and thus provided substantial evidence of the extension of the evolutionary principle to man The full significance of this work can be understood only in scientific circles, in which it has taken a permanent place. To the public he was a fearless champion of scientific thought and intellectual freedom, possessing exceptional gifts of lucid exposition in his literary style and lectures, and using them continuously in social service. The symposium which we shall publish in our next issue will, we hope, induce workers and thinkers of the present time to turn to Huxley's life and writings for the stimulus and guidance which are as much needed now as they were in his own days if science is to come into its kingdom

THE Governors of the Imperial College of Science and Technology, South Kensington, have made special arrangements for the celebration of the centenary of Huxley's birth During the afternoon of Monday next, May 4, there will be an exhibition in the Zoological Department of the College, followed after tea by an address to be given by Prof. E. B. Poulton on Huxley's zoological work, and in the evening at 8.30 a reception will be held by Lord Buckmaster (chairman of the Governing Body) in the

Royal School of Mines, Prince Consort Road. Huxley was professor of biology at South Kensington from 1854, and was Dean of the Royal College (then Normal School) of Science and the Royal School of Mines from 1881 until his death in 1895. He was also actively interested in the formation of the Central Technical College, which is now, under the name of City and Guilds (Engineering) College, one of the three institutions federated to form the Imperial College. It is thus appropriate that the chief memorial of Huxley's great work should be in some form at South Kensington, and the Governors of the Imperial College hope to raise sufficient funds for a suitable purpose. In moving to this end, the Governors are following the advice given them in 1923 by a meeting of the representatives of the principal institutions with which Huxley was actively connected, including the Royal, Linnean, Geological, and Zoological Societies, the British Association, the Board of Education, as the official successors of the old Science and Art Department, the Education Committee of the London County Council, as the successors of the London School Board, the Hydrographic Department of the Admiralty, the Royal College of Surgeons, the University of London, and the Natural History branch of the British Museum. For the future May 4 is to be recognised at the College as an annual holiday.

In our issue of April 25, p. 613, reference was made to the fact that the American Museum of Natural History depends largely for financial support on a large body of regular subscribers, and it was suggested that it would be well if the British Museum (Natural History) could obtain similar assistance. That additional funds are needed for work of the first scientific importance is obvious from the letter appearing elsewhere in this issue (p. 638) from Sir Sidney Harmer, Director of the Museum. A modest expedition has been sent out to Tanganyika Territory by the Trustees of the British Museum to a locality which is known to be rich in dinosaur remains, and the funds in hand will allow of work during the present season on a limited scale. It would appear that the remains, including some of gigantic animals, are lying on the surface or close beneath it, and that a well-fitted expedition could obtain specimens which would be of inestimable value to science. However, as Mr. C. W. Hobley pointed out in NATURE of April 18, p. 573, in an article describing the region and its inhabitants, the conditions are such that the best results can only be obtained by a carefully organised expedition with full technical and transport staffs. Sir Sidney Harmer's letter should drive home the urgent needs of the expedition and will, we hope, produce the necessary and practical assistance which he asks. The American Museum of Natural History has been able to fit out an expedition to Central Asia which has been in the field for several years in succession, exploring and digging with striking results. It is surely not too much to expect that the appeal for the comparatively small fund necessary to work an area already known to be strewn with interesting animal remains will meet with ready response.

The name of Prof. Bohuslav Brauner, Director of the Chemical Institute of the Charles University of Prague, is familiar to many men of science in Great Britain and elsewhere. It is therefore a pleasure to congratulate him on attaining his seventieth birthday on May 8. Prof. Brauner is a grandson of K. A. Neumann, the first professor of chemistry at the Polytechnic High School in Prague. He speaks and writes fluently in no less than six languages, namely, Czech, English, German, French, Russian, and Italian, in addition to a perfect knowledge of Latin and Greek. In chemical science he has acquired an international reputation. He was the first to liberate (in small amounts) the element fluorine from fluoplumbates, and established the complex nature of didymium, separating out the praseodymium. The well-known "critical discussions" of the atomic weight determinations which preface the accounts of each element in Abegg's "Handbuch" are his work. He was an early and vigorous supporter of Mendeléeff's periodic classification of the elements. Prof. Brauner established, but not without opposition, that beryllium is a divalent metal and has an atomic weight 9, thus heading the group of alkaline earth metals in Mendeléeff's system. He was also instrumental in securing the adoption of oxygen (16) as the basis of atomic weight determinations, a large number of which he carefully redetermined himself, devoting much effort to a valuable study of the rare-earth metals. In Bohemia he has done much to foster an interest in science, and through his efforts in 1903-4 the Chemical Institute was erected. In commemoration of his seventieth anniversary a "Jubilee volume" (mainly in English) is being published as a special number of the *Recueil des Travaux Chimiques des Pays-Bas* (price 12*s.* 6*d.* from Dr. W. P. Jorissen, 11 Hooge Rijndijk, Leiden, Holland). This volume will contain thirty-four communications from Prof. Brauner's friends in England and abroad, including prominent chemists, and describing original and recent researches, hitherto unpublished, in general, inorganic, analytical, organic, physical and electrochemistry. It will certainly be of interest to many chemists and physicists.

Referring to a point in our leading article on February 21, Mr. A. E. Bostwick, librarian of the St. Louis Public Library, Olive, 13th and 14th Streets, St. Louis, Missouri, writes stating that *aeroplane* is derived from *aero-* + *planet*, as is given by the American New Standard Dictionary (1914), of which Mr. Bostwick was an associate editor, and as is correctly illustrated in the title of the Norwegian publication the "Aeroplanet"—the air wanderer—(1918). It is difficult, however, to see how the final *t* of the Greek root can be dropped to form *aeroplane*. The New Dictionary of the English Language, Oxford, gives the usual derivation from *aero-* + *plane*, which is unassailable so far as Great Britain is concerned. The word *plane*, as denoting surfaces which are "substantially" flat, in patent law jargon, has been established by the custom of more than a century, while the evolution of *aeroplane* to denote first a lifting surface and afterwards a flying machine is

more than half a century old. Sir George Cayley introduced *plane* in this sense in his remarkable articles on "Aerial Navigation," in *Nicolson's Journal of Philosophy* (1809), and Thomas Walker uses *plane* for wings, shown as curved in sketches, in his "Treatise on Aerostation," 1831. F. H. Wenham introduced *aeroplane* to denote a lifting surface in the first report of the Aeronautical Society (1866), and D. S. Brown used *aeroplane* to denote a complete flying machine in the Society's eighth report (1873). Our correspondent further suggests, out of wide experience of American libraries, and of editorial work on encyclopedias and dictionaries, that in the United States *aeroplane* holds its own in technical discussions, and is used as frequently as *airplane*. The point made in our leading article was that the National Advisory Committee for Aeronautics had adopted *airplane* officially. It also appears in numerous aeronautical and engineering journals of standing, but this need not controvert Mr. Bostwick's estimate for the whole range of American publications.

WE have received from the Science Society of China a pamphlet setting out, from a Chinese point of view, how best the Boxer Indemnity could be used. The Society is of opinion that a golden opportunity which occurs once in a thousand years would be lost, or indefinitely postponed, if the funds available either were divided among the Provinces or were devoted to river conservancy or railway construction, but that a maximum of usefulness might be attained if they were expended on pure research work. This is interpreted to mean the establishing of a model national research laboratory for physical, chemical, biological, and industrial work, the subsidising of laboratories of good repute, whether existing as independent institutions or as forming part of universities, and the founding of scholarships for research students. Besides this, the Society favours the establishing of libraries and museums and the endowing of Chinese chairs of literature and philosophy in foreign universities, but fears that the sums available —strangely understated, dollars being confused with pounds—will not cover so large a programme. The Society is strongly of opinion that general principles should be settled before individuals are appointed to allocate the funds. These should be, it is suggested, entrusted to a Board of Trustees under exact terms of reference, and the members, who should be scholars of repute and men of sterling character, should be appointed equally by both countries.

THIS scheme of the Science Society of China, which was published last August, was in September followed as to its general outlines in the scheme adopted by the United States. It doubtless sets out the results of the negotiations which actually took place between Peking and Washington. We note that the Society restricts its suggestions to the advancement of science, concerning itself with instruction rather than education, and limits co-operation between Chinese and foreigners to partnership on a Board concerned solely with the allocation of funds. To us this seems a somewhat barren use of the golden opportunity depicted. What China needs in its education, besides the addition of science to letters, is a system which aims at producing leaders and not merely students, and to promote this she needs in the educational field that kind of help from foreigners, which has brought stability and efficiency into the customs and the postal services by firmness of administration.

EVERY student of the natural sciences must be familiar with the name of Joseph Leidy, and yet each one may wonder at his fellow's familiarity. Few to-day can approach Nature from so many sides and to such good effect. Leidy was for thirty-eight years professor of human anatomy in the University of Pennsylvania, he was for forty-six years an officer of the Philadelphia Academy of Natural Sciences. As author of "A Flora and Fauna within Living Animals" (1851) and of sixty papers on the subject, he is rightly claimed as the father of American parasitology, and yet he has equal right to be styled father of American palæontology, his most perdurable, and probably his best-known, work is the beautiful monograph on "Fresh-water Rhizopods of North America". He was a mineralogist, well versed in gem-stones, his first collection was of flowers, and he was a competent botanist. His skill as a draughtsman and his love of natural objects made him primarily a descriptive naturalist, and as such pre-eminent "he never," says Dr. H. F. Osborn, "made an incorrect observation or published an incorrect figure". But he was no mere accumulator of facts, for he was an evolutionist before Darwin, an experimental critic of spontaneous generation before Pasteur. It was, indeed, fitting that the centenary of his birth should have been commemorated on December 6, 1923, at Philadelphia, and that there should now have been issued a verbatim report of the many admirable addresses delivered on that occasion, but we regret that no indication is given of where or how the report can be obtained.

THE opening of the Lewis Evans' collection of historic scientific instruments in the Old Ashmolean Building at Oxford has been arranged for May 5. The ceremony will be preceded by the conferment of the degree of D.Sc. *Honoris causa* on Mr. Lewis Evans in the Convocation house. At 2.30 P.M. the Earl of Crawford and Balcarres will deliver an address in the Divinity School and will then pay a formal visit to the collection in the Old Ashmolean Building. The collection will be open to the general public on weekdays between the hours of 11 and 4. An illustration of the building appeared in NATURE for March 3, 1923, on the occasion of the Wren bicentenary celebrations, and Mr. R. Gunther informs us that he has since found additional evidence in support of his view that this building, with but small alterations, is the "College of Science" that was designed by Wren to be erected on the site in Arundel Gardens presented to the Royal Society by Henry Howard. Proving too costly, the building was not erected in London; but when a scientific institution was needed for the Oxford Philosophical Society and for Ashmole's "rarities," Wren's old plan was adapted and adopted.

THE annual congress of the South-Eastern Union of Scientific Societies to be held at Folkestone on June 3-6 should attract a large number of delegates and friends. The officers of the Union for the coming year are as follows *President-elect*, Sir John Russell, Director of the Rothamsted Experimental Station, *Presidents of Sections*, Botanical, Mr A G Tansley, Geological, Mr A. L Leach, Zoological, Mr E C. Stuart Baker, Regional Survey, Mr. Geo. L Pepler The presidential address to the congress will deal with the place of science in rural life, and is certain to be of much interest Mr Tansley, in his address to the section over which he presides, will deal with the vegetation of the English chalk, Mr Leach with new road sections in north Kent, Mr. Baker with field naturalists and evolution, and Mr Pepler with regional survey in east Kent The evening lectures will be by Mr D Ward Cutler on "Life in a Garden Soil," Sir Arthur Smith Woodward on "The Evolution of Fishes," and Capt. J J Eckersley on "Broadcasting" The afternoon excursions include a novelty in the shape of a trip to Dungeness, that wild and remote shingle-tract which forms the seaward extension of Romney Marsh Here both plant and animal life are unique and fascinating Dover Castle, and the country behind Dover, will be visited, as also the recently excavated Roman remains at Folkestone, and several other places of interest A Congress Museum, exhibiting current work by members of the Union, is in course of preparation, and should prove a most attractive adjunct to the gathering A Handbook of Local Surveys is being prepared and will be published before the congress The chapters—about twenty in number—will deal with local flora and fauna, geology, ecclesiastical architecture, Romano-British remains, and other subjects of interest Copies of the book (price 2*s*) may be ordered from the Secretary of the Folkestone Natural History Society, 16 Manor Road, Folkestone, who is also one of the local secretaries of the Congress.

THE first of the two annual conversaziones of the Royal Society is to be held on Wednesday, May 13, at 8 30

SIR THOMAS H HOLLAND, Rector of the Imperial College of Science and Technology, South Kensington, and formerly Director of the Geological Survey of India, has been elected president of the Institution of Mining and Metallurgy

WE learn that it is intended to undertake the preparation of a biography of the late Dr W H. Maw, editor for many years of our esteemed contemporary, *Engineering* Those of his personal friends, colleagues or correspondents who may have interesting material, especially in the shape of personal reminiscences or letters, to contribute, are requested to communicate with Mr W E Simnett, c/o The Institution of Civil Engineers, Great George Street, London, S W 1.

THE World List of Scientific Periodicals has now grown considerably beyond its original size, with the result that the next issue will be in two volumes, one to be issued this month, and the other by the end of the year The List will be published by Mr. Humphrey Milford of the Oxford University Press. Subscriptions from Great Britain and Ireland will become due on May 15 and from other parts of the world at later dates · they should be addressed c/o Zoological Society, Regent's Park, London, N.W.8.

DURING the course of a recent lecture to the Society of Glass Technology on "Glass as an Instrument of Human Progress," Prof. W. E. S. Turner stated that he has had discussions very recently with manufacturers of optical instruments as to the best source of optical glass at the present time. It is very gratifying to learn that in the view of manufacturers whose reputation depends on their obtaining optical glass of the finest qualities, British optical glass is regarded as entirely superior to that of Continental or other makes Two well-known instrument makers expressed the opinion that in view of the prejudices, both of the general public, and frequently, also, of scientific workers, in favour of instruments made from Jena optical glass, the present state of affairs ought to be widely advertised

THE value of the intensive study of a small region as an introduction to wider geographical work is now recognised in most schools of geography and also in some secondary schools A useful pamphlet, which claims to be no more than a guide to methods and sources of information, has been written by Mr. C G Beasley ("Local Geography." London: T. Murby and Co Price, 1*s* 6*d*) The pamphlet begins with a scheme of regional survey in which Mr Beasley shows how to link the human with the physical geography of a district, and discusses the preparation of a map or diagram to show types of land utilisatron The last section of the book is a useful but not exhaustive account of the sources of information The pamphlet merits the attention of teachers who aspire to give a sound basis to their geographical work.

WE have received Heft 1 (for January) of a new German monthly periodical—the *Anzeiger für Schädlingskunde*. It is intended for the publication of short original articles and also as a medium for issuing notes and other announcements relating to the German Society of Applied Entomology, to the members of which it is supplied gratuitously. The editors are Dr. K. Escherich of Munich and Dr. F. Stellwaag of Neustadt a H. The journal is published by the firm of Paul Parey of Berlin, and the present issue consists of twelve pages, but its size (28 cm. × 20·5 cm.), double columns and small type, allow of a larger amount of letterpress than might appear at first sight. It contains four short contributed articles and certain news items. The articles include one by Dr. Escherich, on the transference of wireworms through forest-litter (Waldstreu), and a longer contribution by Dr. H Eidmann on the pyralid moth *Dioryctria splendidella* H.S. and its importance to forestry, both articles being illustrated by text-figures. The other contributors are Dr. A. Frhr. von Vietinghoff-Riesch, who writes on the pine moth and the bird world, and Herr Jac Schlösser, who describes his experiences with arsenic "burning" in the control of fruit-tree pests.

SOME indication of the valuable work which is being done by the Canadian Government in investigating

the customs and beliefs of its Indian population, as well as in preserving a record of such of their traditional songs, legends, and ceremonies as have not already passed beyond recovery, is furnished by the Report of the Department of Mines for the period ending March 31, 1924, which has just been issued The section dealing with the work of the Anthropological Section of the Victoria Memorial Museum shows that, in the course of the year, six scientific trips were undertaken which covered investigation among the Bella Coola, the Gitksan of Skeena River, British Columbia, the Carrier Indians of Bulkley River, B C , and archæological excavations in Ontario Some of the results of these expeditions were submitted to the British Association at the Toronto meeting last year Perhaps the most noteworthy material obtained was that bearing upon the ceremonial dances of the Bella Coola by Mr McIlwraith, which have thrown much light upon Indian psychology and afforded an opportunity for collecting valuable information on the chieftainship, government, magic, mythology, etc. More than one hundred songs were recorded by phonograph

IN September of last year the Fuel Research Board of the Department of Scientific and Industrial Research issued a pamphlet which described the Arley Seam of the Lancashire Coalfield, and pointed out that this was to be the first of a series of similar pamphlets dealing in detail with the physical, chemical, and other characteristics of the individual coal seams of Great Britain. In pursuance of this scheme the Board has recently issued Part 1 of a report on the Ravine Seam of the same coalfield (London H M Stationery Office, 1925 1s 6d net) The seam is fully described in all its details, as it appears in different parts of the field, the variations which it undergoes being clearly indicated There are numerous analyses, proximate and ultimate, together with a good study of the composition of the inorganic matter present Washery tests and microscopical examination of the coal are also included It is to be regretted that the more modern method of X-ray examination of the coal in order to determine the distribution of its inorganic contents has not been made use of It is stated in the preface that "large scale experiments, including steam raising tests, the carbonisation of the coal at low and high temperatures, and the utilisation of the coke in a water gas plant, are in progress at H M Fuel Research Station, and the results will be published as Part 2 of this report"

APPLICATIONS are invited for the following appointments, on or before the dates mentioned, an assistant lecturer in geography in the University of Manchester —The Internal Registrar (June 8), a probationer for the Indian Forest Service—The Secretary, Services and General Department, India Office, S.W 1 (July 1); principal of Agra College—The Commissioner of Agra, India (July 10); a reader in organic chemistry in the University of the Punjab, Lahore—The Joint Registrar (July 31), a physics laboratory attendant in the Science Department, University of Durham ; Head of the Department, South Road, Durham

Our Astronomical Column.

COMETS —Mr. B M. Peek of Boscombe and Mr. G. P B. Hallowes of Wimborne have succeeded in obtaining a considerable number of observations of Reid's Comet though its meridian altitude was only 11° Two of Mr. Peek's observations are given (referred to the equinox of 1925 0).

	G M.T.	R A.	S Decl.
Apr	15d 22h 54·5m	13h 3m 39 68s	25° 59′ 37 3″
	24 22 13 4	12 50 1 36	28 12 48 0

They are corrected for differential refraction, but not for aberration or parallax Taken in conjunction with the early observations given a few weeks ago, they will permit the deduction of improved elements

A new orbit of Orkisz's comet has been computed at Copenhagen; but it differs so slightly from Mr Merton's orbit (NATURE, April 25, p. 616) that it is unnecessary to give it Prof. Banachiewicz of Cracow has directed attention to the resemblance of the orbit of the comet of 1500, for which Dr. Hind found the following elements from Chinese observations: T 1500 May 17, ω 20°, Ω 310°, i 105°, log q 0·146. It is desirable to observe the comet as long as possible in order to decide the question of identity. Since it is travelling into high north declination, it is well placed for this purpose.

The following orbit of Schain's Comet has been deduced by Dr. A. C. D. Crommelin from observations on March 23 at Bergedorf, April 2 and 14, by Dr. W. H. Steavenson at Norwood.

T	= 1925 Aug. 6·918 G.M.T. (new)
ω	200° 31′ 10″
Ω	357 29 12
i	146 55 47
log q	0·629662

T is not likely to be more than a few days in error. Unfortunately, the comet will be hidden in the sun's rays at the time of perihelion, but it will be observable again from November onwards

It should be noted that this comet was independently discovered by Señor Comas Solà at Barcelona a day after Mr Schain detected it custom therefore allows the coupling of the two names as joint discoverers, as the second detection took place before the news of the discovery had been distributed Both discoverers found the comet in the course of their regular photographic search for new minor planets

PROPOSED NEW ASTRONOMICAL CO-ORDINATES — In the *C R. Acad Sci*, Paris, March 2, M C Solà points out that, in order to study the sun's motion, a system of co-ordinates is required which does not rotate. A uniform rectilinear motion of translation of the origin need not be considered, since in infinite space such a motion has no real meaning Since the position of the centre of gravity of the Milky Way is not known, it cannot be employed as the origin, and a system of axes based on the stars, particularly the brighter ones, most of which have definite proper motions, cannot be regarded as necessarily free from rotation Under these conditions, it is better to take the centre of the sun as origin, and to measure the position of the stars in the different streams which form the Milky Way with respect to axes passing through it, and fixed with respect to the most distant objects visible, such as the globular star clusters, or, possibly better still, the spiral nebulæ As these can be regarded as being practically at an infinite distance with respect to the bright stars, the axes so defined could be regarded as practically free from rotation It is pointed out that modern astronomical knowledge demands the degree of exactitude which could be obtained in this way.

Research Items.

THE GOD SETEKH.—Some interesting deductions bearing upon the development of religious beliefs in ancient Egypt are made by Mr. R O Faulkner in the March number of *Ancient Egypt* from references to the god Setekh in the Pyramid Texts The centre of the worship of this little-known deity appears to have been Ombos in Upper Egypt, and he appears to have been to some extent the embodiment of the destructive powers of Nature. In the Osiris and Horus myths of the later texts stress is laid upon his malevolent activities, but the Pyramid Texts, the oldest beliefs concerning him which have come down to us, present contradictory ideas which probably represent different stages in his history Originally he ranked as equal with the other gods. Thus his relations with Horus and Osiris vary in three ways (1) Setekh is without either friendliness or hostility, but stands over against them as representing a different tract of the country, (2) Horus and Setekh co-operate for the benefit of the deceased, (3) Setekh is the mortal foe of Horus As the Osiris cult gained ground Setekh became hostile to him also It is not always clear whether Horus is the old tribal Horus or the son of Isis Probably the tribal myth was transferred bodily into the Osirian legend, the original cause of hostility being the feud for the supremacy of Egypt settled in the lawsuit which was brought before the court of the gods at Heliopolis The reversal which converted Setekh from one of the principal gods of the Egyptian pantheon to an outcast was no doubt due to political causes, and the frequency with which he appears as the enemy of Osiris is to be attributed to the comparatively late rise of the cult of that deity when the evil character of Setekh had been fully established.

IRISH SEA HERRING.—The report for 1923 on the Lancashire Sea-Fisheries Laboratory contains three papers dealing with investigations into the life-history and fishery of the herring in the Irish Sea Mr A Scott, from the results of his examination of stomach contents, concludes that the movements of both herring and mackerel are influenced to a very considerable extent by the presence or absence of plankton organisms, and believes that it should be possible to predict with a fair amount of accuracy whether these fishes will arrive earlier or later than usual, by making adequate observations on the plankton The food of the herring during the fishery in June, July and August 1923 consisted of the few months' old stages of fishes such as rockling, sand-eels, clupeoids, gurnard and long rough dab, along with the crustaceans Meganyctiphanes, zoea and megalopa stages of crabs, larval pagurids, Pandalus, and various Copepoda Mr. W. C Smith, in a study of the composition of the Manx herring shoals, states that young fish approach the coast in May and remain close to the land for about three months, increasing in abundance during June and July, and moving to the deeper water off the Calf of Man in August Older fish come in later, appearing on the Irish side of the Channel in July, and gradually working across to the "Calf" waters to meet the other shoals in August. Mr W Birtwistle and Miss H M Lewis made an extensive examination of Irish Sea herrings in 1923 with regard to age, growth, and maturity, and now put forward two interesting hypotheses (1) Irish Sea herrings are all autumn spawned, (2) herrings spawned in the very early autumn will show a greater mean length and a more advanced mean stage of maturity than herrings spawned in the late autumn

SEX DIFFERENTIATION IN THE CHICK.—In a paper published in 1921 (*Jour. Exp Zool*, v. 33), Minoura put forward the claim that he was able to produce in the developing chick embryo intersexual forms due to the action of the sex-hormones secreted by a gonad of the opposite sex grafted on to the chorio-allantoic membrane. His work was of fundamental importance, since it provided the only experimental support of Lillie's theory of the causation of free-martin in cattle. Minoura's experiments were recently repeated by A. W Greenwood (*Brit. Jour Exp. Biol*, 2, No. 2, 1925) The technique has been greatly improved and a sex-linked cross was used, making it possible to identify the sex of the chicks at an early stage in development Although the author obtained many successful grafts, he has entirely failed to confirm Minoura's results He shows that Minoura cannot be said to have demonstrated conclusively that the differentiation of the sexual apparatus of the host embryo can be modified towards an intersexual condition through the action of a gonad graft of the opposite sex Further, he shows that the conditions obtaining in the bovine free-martin are not reproduced in these experiments, in that in the latter the embryo is exposed to the specific action of the grafted gonad alone, whereas in the former the female co-twin is exposed to the action of all the internal secretions from the male

A MULTIPLE TEMPERATURE INCUBATOR.—C. B. Williams and T. W Kirkpatrick describe (Ministry of Agric, Egypt, Technical and Sci Service, Bull No 38, 1924) useful forms of this apparatus designed to enable them to study the behaviour of cotton pests at a number of different temperatures in order to find their death-point, the points of greatest and least activity, and their rates of development at temperatures close together and approximately constant. A copper or aluminium bar, tube, or trough is inserted at one end into a hot tank and at the other end into an ice-box—all suitably insulated so as to minimise changes of temperature In the first apparatus a copper bar was employed, and in this 71 holes were bored at intervals, each provided a place where a tube could be maintained at a different temperature the daily variation of which was found in any one case to be less than half a degree The authors suggest that bacteriologists and mycologists may find the apparatus useful.

A NEOTENOUS SALAMANDER FROM JAPAN.—M. Sasaki (Jour Coll. Agric., Hokkaido Imp. Univ., Japan, vol. 15, pt. 1., 1924) gives an account of the bionomics of a salamander, *Hynobius lichenatus*, which, in Lake Kuttarush, occurs as a typical neotenous form, regularly breeding in that phase While the phenomenon of neoteny is not rare, particularly among the Urodela, reproduction in the neotenous condition has hitherto only been known in the Axolotl. The larvae of neotenous parents underwent normal metamorphosis under laboratory conditions. From experiments the author concludes that the main factor which brings about neoteny is low temperature, to which, however, must be coupled a rich food supply. The temperature must not be so low as to impair the vitality of the animals and inhibit feeding, since starvation, even under otherwise good conditions, stops both growth and metamorphosis. Conditions suitable to neoteny, a permanent temperature of from 4°-10° C. and a rich food supply, were found to exist in the Nitella zone of Lake Kuttarush, where neotenous forms of *Hynobius lichenatus* were found by the author in abundance and regularly reproducing.

EMULSIFIED OIL-SPRAYS FOR LEMON CULTURE.—A large number of the lemon groves of Florida are

located in artesian well districts, and the water from these wells is utilised in spraying the trees for white flies and scale insects Unfortunately this water is particularly hard, and great difficulty is met with in mixing unstabilised oil-emulsions with it. Accordingly the water was treated with caustic potash fish-oil soap prior to adding the emulsion, but the method involved trial and error, caustic soda and fish-oil soap, used separately, were found more economical Where the rust mite prevails, as in the United States and the West Indies, other measures have to be taken Messrs W. W Yothers and J. R Winston give details of the use of combination sprays both for rust mite and for other insects, in Bulletin 1217 of the United States Department of Agriculture (1924) These sprays concern the use of soda-sulphur or potash-sulphur solutions mixed with unstabilised oil-emulsions, but they are not always so effective as they might be, and a lime-sulphur solution has been employed to greater advantage as an insecticide Unfortunately there is again a difficulty in getting the lime-sulphur solution to mix with unstabilised oil-emulsion. Experiments in the direction of stabilising oil-emulsions have shown that the use of colloidal substances such as glue, skimmed-milk powder, casein, wheat flour, corn-starch and laundry starch produces the desired effect The combination spray is made by filling a spray tank full of water, to which is added the requisite amount of lime-sulphur solution, then the stabilised oil-emulsion is added, consisting, for example, of paraffin or lubricating oil, water, caustic soda, fish-oil soap, and glue After agitation the spray is ready for use, and it can be applied to foliage, branches, or fruit without injury, providing that the whole process of mixing has been carefully carried out and the correct proportions of each ingredient employed

UPPER AIR CIRCULATION OF THE ATLANTIC —The upper air circulation of the Atlantic Ocean is dealt with by Mr E. W Barlow of the Meteorological Office, Air Ministry, in Professional Notes, vol 3, No 39 An historical account is given of upper wind currents and temperatures over the Atlantic obtained chiefly from kites and pilot balloons, and our present knowledge of air circulation in relation to trades and counter trades is indicated The meteorological aspects of Atlantic flying are dealt with, these include sea-fog and conditions which create "bumpiness," and advice is given as to the most favourable heights for flights to North and South America. The work is of considerable interest, and the author has brought together a good deal of useful information Some early discussions by the Meteorological Office, and especially those carried out under the supervision of Capt. Toynbee on the Atlantic equatorial regions, scarcely receive the attention they deserve These earlier discussions show that in the region of the Doldrums, with north-east winds at the surface, the direction of upper clouds is generally from south-east, and with surface winds from south-east the upper clouds are about equally from south-east and north-east. To the north of the Doldrums and to 20° N., with wind north-east there is a high percentage of the upper clouds from south-west. To the south of the Doldrums and to 10° S, with wind south-east, there is a high percentage of upper clouds from south-west and a fairly high percentage from north-east. These results are obtainable for each month. Table IV., by the author, gives the times in hours required for flight between Newfoundland and Ireland under best, ordinary, and worst conditions. The Meteorological Office "Synchronous Weather Charts of the North Atlantic Ocean, 1882–3," have been used for these calculations. These charts represent the weather conditions for a single year, and the weather in any other year would in all probability be very different, a fact which should be emphasised.

CLIMATE OF THE NETHERLAND INDIES —The Royal Magnetic and Meteorological Observatory of Batavia, in Verh No 8, vol 1, part 7, gives a discussion of the weather by Dr. C Braak In addition to the Dutch text English summaries are given Favourable conditions for lightning and thunder appear to be calm air and an unstable vertical temperature distribution, extending to a great height The bulk of tropical thunderstorms are heat thunderstorms, short-lived, and of relatively small extension Fewer persons seem to be struck by lightning in the East Indies than in Europe, and fires caused by lightning are very rare Special kinds of trees are struck fairly frequently, in particular the coco-nut palms Hail is said to be a rare phenomenon in the tropics, but instances are given of the occurrence of hailstorms, they are most frequent in the monsoon changes, as is the case with thunderstorms No marked connexion is shown between pressure and sunshine or pressure and temperature, but there appears to be a pronounced relationship between sunshine and temperature A comparison is made between the climate of the Netherland Indies and that of other regions With regard to temperatures of the wet bulb thermometer, it is noted that whilst at Batavia the maximum heat, although disagreeable, can be endured without too much discomfort, the same cannot be said of many other places in neighbouring countries Destructive cyclones are rare A comparison is made of the climates of those regions in the Archipelago and outside of it where the best results are obtained with different crops

THE JAPANESE EARTHQUAKE OF SEPTEMBER 1, 1923 —Several papers have recently been published on the great Japanese earthquake of 1923, one of unusual interest being that by Mr K Shiratori (*Japanese Journ of Astr and Geoph*, vol 2, 1925, pp 173-192) From the seismographic records at Sendai, he locates the epicentre in Sagami Bay off the southern end of the Miura peninsula, and the focus at a depth of 44 km From September 1 until the end of the year, 652 after-shocks were recorded at Sendai, of which 80 were comparatively strong The epicentres of the latter are distributed in three zones, together in the form of the letter N The first zone is parallel to the Fuji volcanic zone and traverses the Idzu islands The second, branching from the first near Tanzawa Mountain, runs along the Miura peninsula, crosses the Uraga channel, and meets the third zone, which follows the line of the Yamiso Mountains, off the east coast of the Boso peninsula These zones are so intimately connected that, when one is active the others also come into action. Mr. Shiratori remarks that observations of the earth-potential at Sendai show abnormally large variations during near earthquakes, those at the time of the great earthquake being very marked

VOLCANIC ACTIVITY IN KILAUEA —In his interesting account of the recent eruption of Kilauea, Dr T A. Jaggar remarks on the periodicity of the great eruptions of that volcano (Hawaiian Volcano Obs, Mon Bull. for April and May 1924) These have occurred in the years 1790, 1823, 1855, 1887, and 1920 (the culminating year of the present cycle), the mean interval between successive eruptions being thus 32·5 years. For Vesuvius, about 33 years is a common interval, the last two eruptions having occurred in 1872 and 1906. "It would appear, and this agrees

with Omori's work in Japan, that 130, 65, and 32·5 years are intervals significant in volcanism." In the *Volcano Letter* for February 19, Dr Jaggar uses the percentage of dead cones in a district as an index of comparative volcanic activity in different Pacific regions (Sumatra, South Japan, the Fuji cross-zone in Japan, the Kurile Islands, the Tonga Islands, and the Hawaii Islands). He concludes that the extinction becomes less and the activity greater as we advance from the continental to the oceanic districts.

Oil and Gas Possibilities in Montana.—In a recent publication of the Department of the Interior, United States of America, we have a striking example of the value to a nation of highly organised geological survey, one that exists not only to amass and co-ordinate data of regional geology, but also to disseminate results and conclusions of contemporary economic import. In an area lying to the south of the Bearpaw Mountains, Montana, some little oilfield development had already been in progress, but had met with indifferent success, the United States Geological Survey accordingly sent Mr Frank Reeves to investigate the geology and petroleum possibilities here, and the results of his survey are now available to the public in an excellent bulletin (751-C), one of high technical and literary merit. The author concludes that an area is favourable from a commercial point of view because the strata (*i.e.* Cretaceous) contain abundant organic material "of the proper kind to yield oil", further, that there has been sufficient, but not too much, regional alteration of the sediments to influence oil formation from this organic material, that there are suitable reservoirs of porous strata, that structures favourable to oil accumulation are present, that there has been no escape of oil by faults or as a result of flushing by circulating ground-water, that the character of the water found in one oil well sunk is favourable to the existence of oil, and that gas in commercial quantity has been located within the area. If geological advice can be of positive value in minimising risk of failure, here is a clear case where the chance is worth taking, though, as the author conscientiously remarks, "no one should invest money in the drilling of wells here unless he can afford to lose it." For the rest, the survey of this area shows it to be geologically typical of much of the north-central Montana country, characterised especially by its full Cretaceous development, its complexities of folding and faulting—the last factor of a somewhat unique kind in this area—and its abundant evidence (though not always on a commercial scale) of bitumen in one form or another.

Mineralogy of Fossil Bone.—The common belief that fossil bones are generally silicified is completely disproved by A. F. Rogers, who has thoroughly investigated a collection of 300 different examples ranging from the Ordovician to recent times, and gathered from widely separated countries in every continent. The evidence, which is convincingly set forth with numerous excellent photomicrographs in the Bull. Geol. Soc. America, vol. 35, pp. 535-56, 1924, shows that fossil bone consists almost entirely of the amorphous mineral collophane, which is also the principal constituent of phosphate rock. Collophane is not a definite chemical compound, but seems to be a hydrous solid solution of calcium carbonate (with smaller amounts of the fluoride and sulphate) in calcium phosphate. Corresponding to this the refractive index of fossil bone ranges from 1·573 to 1·621, though the smaller range, 1·595 to 1·615, includes the great majority of the specimens. The values show no regular relation to geological age. Bones seem to become fossilised in a comparatively short time, and after that no further changes of importance take place. The collophane of fossil bone exhibits a feeble double refraction due to strain, and a thin section of the spine of a Permian reptile even displayed a distinct pleochroism from pale to deep yellow. This is probably the first record of pleochroism in an amorphous substance. Of all the specimens examined only three were found to be silicified. Various forms of silica, together with calcite, are commonly associated with collophane, but whereas the latter fills up the pores left by the removal of organic matter, and so preserves the structure of the bone, the associated minerals are usually merely the infillings of cavities. Thus it is found that the well-known opalised bones from White Cliffs in New South Wales are internal casts showing no organic structure.

Defining Iron and Steel.—The definitions of steel and cast iron as given by various authorities may be divided into two classes: (1) those based on the principal properties and methods of production of these materials, and (2) those based on the constituents present, *i.e.* on the carbon content. For example, steel is defined as an iron alloy which can be hardened by quenching or results from melting and is very tough, or is an iron alloy containing a certain quantity of carbon which when quenched is hard and elastic, etc. A definition based on the method of production is not really appropriate, for when a new method has been discovered, the definition has to be altered. The definition based upon properties is also inadequate, for the words "hard," "tough," and "elastic" are all relative. In a recent issue, Vol. 13, No. 2, of the Science Reports of the Tohoku Imperial University, Prof. Honda discusses this question and concludes that the only satisfactory definition is on the basis of composition. He defines steel as an iron carbon alloy with a content of carbon lying between 0·035 and 1·7 per cent. Cast iron is defined as an iron carbon alloy the carbon percentage of which lies between 1·7 and 6·7. The lower limit of 0·035 in the case of steel is chosen because, up to this amount, the carbon is retained in solid solution in the iron. These definitions take no account of the other constituents ordinarily present in steel and cast iron. While these may be regarded as immaterial in the case of steel, such is not the case for cast iron. However, Prof. Honda's contribution to the question is a step in the right direction.

United States Ordnance.—The issue of the Journal of the Franklin Institute for March contains the address on modern ordnance delivered in September 1924 at the centenary celebrations of the Institute by Major-General C. C. Williams, of the United States War Department. It is devoted chiefly to the improvements which have been effected in the six years since the War, and shows that in almost every type of gun the range has been increased by about 50 per cent. at the expense of a small increase in weight. For sea-coast protection the guns are sixteen-inch and throw a projectile weighing more than a ton a distance of 27 miles. It has been decided that the long-range guns of the "Big Bertha" type are of doubtful value, as their work can be much more cheaply done by bombing aeroplanes. The demolition type of bomb has been considerably developed, and although a 4000 lb. bomb is under trial, it is believed that a 2000 lb. bomb will be the largest size needed. These bombs are timed so as to penetrate to the lowest story of a building or 40 to 60 ft. below the surface of the water before exploding. In this way the maximum effect is produced, and in the case of a ship greater damage is done by a near hit than by a direct one.

Royal Meteorological Society.

THE Royal Meteorological Society was founded under the name of "The British Meteorological Society" on April 3, 1850, and the occasion of its seventy-fifth anniversary was celebrated in London on April 21 and 22. The following brief account of the history of the Society and of its predecessors may therefore be of interest

The first English Meteorological Society was inaugurated so long ago as 1823 Luke Howard, Thomas Forster, and Dr Birkbeck were among its founders, while Prof Daniell was one of its members The Society became dormant shortly afterwards, when Luke Howard moved away from London, and in 1836 a new Society was formed, which was generally known as the Meteorological Society of London One of its members was John Ruskin, who in 1839 contributed to the Society's Transactions a paper from which the following extract is taken .

"A Galileo, or a Newton, by the unassisted workings of his solitary mind, may discover the secrets of the heavens, and form a new system of astronomy. But the meteorologist is impotent if alone , his observations are useless, for they are made upon a point, while the speculations to be derived from them must be on space" The truth of these words is realised more forcibly to-day than ever before, and it is remarkable that they should have been written so long ago

The 1836 Society developed pronounced astrological tendencies as time went on, and this fact appears to have led to the foundation of the present Society in 1850 Mr J Glaisher, F R S , was secretary of the Society from 1850 until 1873, except during 1867-68, when he was president, and apparently his was the guiding spirit in the earlier years of the Society The distinguished engineer Robert Stephenson, F R S., was president in 1857–58 Until 1866 the Society was a voluntary association of members, but in that year a Royal Charter of incorporation was obtained whereby members of the British Meteorological Society became fellows of the Meteorological Society In 1882 permission was obtained from Queen Victoria to change the name of the Society to that at present in use, namely, the Royal Meteorological Society

In conformity with the ideas expressed by Ruskin, the Society at first devoted itself to the expensive task of the collection and publication of meteorological observations from a number of stations, chiefly in England and Wales, as well as to the reading, discussion, and publication of original papers For it will be recalled that in 1850 there was no State provision for meteorology in Great Britain. The results of this work are printed in the "Meteorological Record," which was published annually from 1881 until 1910. In 1911 the work was transferred to the State service, the Meteorological Office. Many investigations were undertaken by the Society in its corporate capacity, and brought to a successful conclusion ; among these may be mentioned the collection of phenological observations from the area of the British Isles, and the annual publication of a phenological report in the Quarterly Journal of the Society. This enterprise is still vigorously pursued, the whole of the work of observation and compilation being voluntarily given. In 1919 the Scottish Meteorological Society, which had been founded in Edinburgh in 1855, was dissolved, and as many members of that Society as so desired were received as fellows of the Royal Meteorological Society.

The celebrations on April 21 and 22 took the form of (1) a visit to Kew Observatory, by invitation of the Director of the Meteorological Office , (2) a conversazione in the rooms of the Society at 49 Cromwell Road, South Kensington , (3) an anniversary meeting, when a lecture on "Clouds and Forecasting Weather" was delivered by Prof E van Everdingen, president of the International Meteorological Committee and Director of the Royal Netherlands Meteorological Institute , and (4) a dinner at the Hotel Rembrandt About 75 persons attended the various functions, and the guests included members of the International Commission for the Exploration of the Upper Air, who had previously held meetings at the Meteorological Office under the presidency of Sir Napier Shaw

The visit to Kew Observatory during the afternoon of April 21 was much enjoyed, fine weather favouring the event The visitors were shown over the observatory, and had the experience of witnessing the release of a registering balloon

The conversazione on the evening of April 21 was held in the rooms of the Society and the visitors were received by Mr C J P Cave, president of the Society, and by Mrs Cave A number of exhibits, many of which had been lent for the occasion by fellows of the Society, were arranged, and Mr F J W Whipple showed a number of experiments, including the formation of halos, coronæ, and the green ray

The anniversary meeting on the afternoon of April 22 was the principal event in connexion with the celebrations The president welcomed the four honorary members who were present, namely, Prof W van Bemmelen, lately Director of the Batavia Observatory, Prof E van Everdingen, Prof H Hergesell, Director of the aerological observatory at Lindenberg, and Prof Th Hesselberg, Director of the Norwegian Meteorological Service and secretary of the International Meteorological Committee The president then read a telegram which had been sent to His Majesty the King, patron of the Society, and the reply from His Majesty, which concludes "The King rejoices in the thought that recent years have seen important advances in the science, and he earnestly trusts that the Society will be able to record still further developments in their valuable and interesting labours" Afterwards a number of addresses of congratulation were read from foreign meteorological institutes and other scientific bodies, and from a number of private persons, including a letter from the venerable Prof H Hildebrandsson of Upsala, foreign member

Prof E van Everdingen then delivered his lecture on "Clouds and Forecasting Weather" He said that failure to forecast the weather 24 or 36 hours ahead can be ascribed to lack of suitable observations, among which are those of the motion of high and medium clouds He showed an example of the improvement in the forecasts which would have been produced had cloud observations been available, and put forward a strong plea for the regular observation and transmission of information regarding cloud motion The methods of the "weather-wise," who use only local observations to foretell coming weather, are ill-defined, but it is not difficult to account for many of their maxims in the light of modern knowledge, as derived from aerological research and the observation of clouds from aircraft The main object of cloud-observation for the professional forecaster ought to be to tell him something definite of the atmospheric conditions in the upper air over the whole area of his map Inversions of temperature usually occur over cloud-sheets, and if the latter are identified at a number of stations, the horizontal

extent of the inversion is defined. Such inversions tend to prevent upward convection and the formation of rain is hindered Complete observations of halo would be of material assistance At de Bilt in 1922, rain followed halo in 70 per cent of cases of halo observations, and only 70 out of 200 rain-days were not preceded by halo observations somewhere in Holland

The anniversary dinner was held on the evening of April 22 After the toast of the King, patron of the Society, had been enthusiastically honoured, Mr H. Mellish proposed the toast of The Services, and Capt H. P Douglas, Hydrographer of the Navy, responded He spoke of the work which is now being done in the Navy in the investigation of the upper air by pilot balloons and registering balloons Sir Philip Sassoon, M P , Under-Secretary of State for Air, proposed the toast of the Royal Meteorological Society He referred to some of the events in the history of the Society, and paid a tribute to the aid which meteorologists had been able to send to the Airship R33, in the shape of weather reports and directions for the best course to be taken, on the occasion of its recent break-away in a gale from its mooring-mast at Pulham The president responded to this toast. Sir Napier Shaw proposed the toast of International Meteorology, and Prof. E van Everdingen responded

R C.

The British Science Guild.

THE annual meeting of the British Science Guild was held in the Salters' Hall on Tuesday, April 21, the chair being taken by the Right Hon. Lord Askwith, president of the Guild.

Reviewing the work of the Guild, the chairman directed attention particularly to its co-ordinative functions, linking together the operations of many different bodies, and to its efforts to bridge the gulf between men of science and the general public Reference was made to the issue of the revised edition of the Catalogue of British Scientific and Technical Books, which now contains more than 9500 titles of books, and should prove most valuable to students, libraries, and manufacturers Methods of obtaining " Science Publicity " are being considered, but this demands the co-operation of leading scientific and technical societies. A new feature has been the formation of six standing committees (National Security, Parliamentary, Health, Research and Industry, Finance, and General Purposes)

An address emphasising the need of increasing knowledge of science among the public, and the application of scientific method to public affairs, was delivered by Sir William Bragg, who pointed out the contrast between the marvellously rapid development of scientific data, and the meagre facilities for letting the public know what was being done on their behalf The forty millions of people in the British Isles are living on the direct application of science, and they should know what science has done, and what it might do in the future. It is unfortunate that scientific men, who spend their days in wresting information from Nature in the laboratory, have not as a rule the supplementary gift of conveying scientific information in a popular form. Publicity for science is needed If, as it is hoped, a proper organisation for publicity in scientific matters could be created, there should be at its head a scientific literary man, and behind it funds sufficient to tide over the first period of its existence

Sir Arthur Newsholme, speaking as chairman of the Health Committee, said that the average life of a child born to-day is some 10 to 12 years longer than it was 30 to 40 years ago This is due to a better knowledge of the laws of health What should be investigated are the causes of evils rather than their alleviation—as illustrated by the millions of headache powders and similar nostrums sold Attention has been directed by the Health Committee to two defects in the Births and Deaths Registration Bill now before Parliament There is no valid verification of the fact of death, and the certificate of death should be regarded as confidential and lodged with the registrar and not handed to the nearest relative.

Major the Hon. H Fletcher Moulton (chairman of the Research and Invention Committee) pointed out that in regard to industry there is a gap similar to that remarked on by Sir William Bragg in connexion with publicity Manufacturers of Great Britain are sometimes blamed for not availing themselves more freely of the results of scientific researches. There is, however, a gulf between the man working in the laboratory and the business man An intermediary, who could demonstrate to the latter how he would benefit from the application of science, is needed. It is in this intermediate stage that Germany has made such rapid progress

Excavations at Cresswell Crags, Derbyshire.

AT a meeting of the Royal Anthropological Institute held on April 21, Mr A Leslie Armstrong read a paper entitled " Recent Excavations on Palæolithic Sites at Cresswell Crags, Derbyshire," describing excavations which had been carried out by him under a Joint Committee of the British Association and the Royal Anthropological Institute The two important sites of Upper Palæolithic date under investigation consist of a rock shelter and a cave respectively The former, excavated between June and October 1924, is situated in front of Mother Grundy's Parlour, the last cave of the Cresswell group excavated by Sir William Boyd Dawkins and the late Rev J. M Mills in 1879 This proved to be an undisturbed stratified deposit with a Palæolithic relic bed 2 feet 6 inches thick The lowest stratum yielded implements of quartzite which, from evidence afterwards obtained in the cave site, are probably referable to Mousterian times Overlying this was a rich deposit from which flint implements, bone tools, and three pieces of engraved bone were recovered. The latter are believed to represent bison, reindeer, and rhinoceros, but all are fragmentary. At the lowest level of this layer was a hearth formed in a hollow scooped out in the basement bed and ringed around with flat stones, on edge, just as Boy Scouts build a fireplace to-day The area around the fire proved the most prolific in antiquities. The flint implements from that level are late Aurignacian in general character, those from the top of the deposit are early Tardenoisian, and those from the intervening layer reveal a gradual development in style and technique from one culture to the other.

The second site dealt with was the cave known locally as the Pin Hole. Excavations in September last revealed that the examination made by Mills fifty years ago had extended to the first seven yards only, and that the remainder of the cave was practically undisturbed. Through the generosity of the Percy Sladen Memorial Fund Trustees and the kindness of

His Grace the Duke of Portland, it has been made possible to undertake a thorough examination of the cave, and work is now in progress there The results already achieved include the discovery of a lance point in mammoth ivory, engraved with a conventional pattern, which is assigned by the Abbé Breuil to the Middle Magdalenian period, and is identical with one found in the cave of La Madeleine itself This implement and others associated are considered to provide the most definite evidence so far discovered at Cresswell for the precise dating of the culture and its correlation in point of time, if not in development, with the classic cave sites of France Considerable data have also been obtained in proof of occupation in Upper Mousterian times and at a still earlier period

At the conclusion of the paper a letter was read from Sir William Boyd Dawkins, chairman of the Committee, in which he entered a *caveat* against acceptance of the engravings on bone from Mother Grundy's Parlour as of human origin In his opinion, they were due to the action of roots In the discussion, Prof. W. J Sollas said that he had no doubt that they were of human origin, while Miss Garrod stated that she was authorised to say that the Abbé Breuil, who had examined the fragments that day, was convinced that the reindeer, and some at least of the lines forming the figure which was thought to be a rhinoceros, had undoubtedly been engraved by man The bison, however, was more doubtful and might possibly be due to root action

The Natural History of Disease in Baltimore, Maryland.[1]

THE publication before us forms one of the admirable reports issued by the Carnegie Institution of Washington, and therefore calls for attention It purports to trace the development of public health in one of the oldest cities in the States, and to correlate, so far as practicable, the ascertainable factors bearing on the natural history of disease in that city during a span of more than a century The attempt is made in nearly 600 pages, beset with elaborate statistical tables and a number of graphs, which have been reduced to an extent which makes them partially illegible

The valuable portion of the work deals with the actual topography of Baltimore and with the details of the gradual development of its public health administration. In 1820 an ordinance was passed making it the duty of all practising physicians to report cases of malignant or contagious fevers to the mayor or Board of Health, and although this and subsequent but very early further ordinances of similar nature were not enforced, they are interesting as preceding by many years similar ordinances (which were enforced) in Great Britain Similarly, health commissioners, corresponding to our medical officers of health, were appointed, antedating the appointment of the similar earliest appointed officers in London and in Liverpool. But although these appointments were made, the rapid growth of Baltimore, its increasing heterogeneity of population, and other factors, have left it far behind in subsequent sanitary practice. The reader will find, in comparing the Baltimore enactments with those in Great Britain, much of interest and of practical value, and the balance to the good does not always rest with English legislation. Perhaps, however, we may agree with Solon in his advice to the Athenians; let us have the best law we can keep, not the best laws that can be made

For epidemiologists and students of natural history generally, however, one looks chiefly to the history of disease prevalence as here presented A vast amount of material has been compiled, Teutonic in bulk, and Teutonic likewise in the failure to sift out what is trustworthy and to save the student unnecessary and wearisome detail Thus deaths and death-rates are given for all causes in the aggregate and for some single diseases from 1812 onwards, although prior to 1875, when death-certificates were first required by law, the only information available was that obtained from the sextons of the cemeteries What proportion of deaths were buried "extra-murally" we can only guess, but the large extent to which deaths of inhabitants in institutions outside the city —which are not recorded in the city statistics— vitiate the statistics given throughout the report, may be gathered from data emerging here and there in the volumes

When we pass to causes of death, difficulties in accepting the data laboriously collected begin to multiply Thus on p 193 is given a list of the causes of deaths named among the burials in the year 1819 "Consumption" is the only item of likely tuberculous nature which appears On p 383 the death-rate from pulmonary tuberculosis for the same year appears as 402 and from other forms of tuberculosis as nil In 1920 the corresponding rates were 128 and 23! On such data, of which an extreme example has been given, are based discussions as to the upward and downward course of the tuberculosis death-rate, which possess very slight value The problem in Baltimore, as in many other American cities, has been complicated by large immigration of Irish, of Greeks, of Russians and Poles, and by a large negro population The statistics deal with these heterogeneous groups as if they formed a homogeneous whole, and on such data, extremely imperfect in other respects, we are asked to accept sweeping conclusions, as for example that the course of the death-rate from tuberculosis in Baltimore has been determined above all other factors by natural selection On similarly imperfect data, to give one further illustration, is based the unlikely inference that although an increasing ratio of the population now attain middle life, these individuals on the whole prove to be poorer risks and less capable of survival to old age than were the proportionally smaller numbers who reached the age of 40 "when natural selection was more searching in its action" To base such a sweeping conclusion on the imperfect statistics of a heterogeneous population, affected by immigration, composed of blacks and whites, of persons of eastern and southern European as well as of British and Irish origin, is extremely indiscreet, and study of the English Registrar-General's figures would have shown its error for a country in which more stable conditions exist, and for which official mortality statistics can be regarded as trustworthy

[1] Public Health Administration and the Natural History of Disease in Baltimore, Maryland, 1797–1920, by Dr. W. T. Howard, jun.

University and Educational Intelligence.

CAMBRIDGE.—Mr H Gilbert-Carter, Trinity College, has been reappointed as curator of the Herbarium. Sir John Russell and members of the staff of the Rothamsted Experimental Station are giving this term a special course of lectures on "The Chemistry, Physics and Biology of the Soil" The Linacre Lecture will be delivered on May 6 by Lt.-Gen. Sir William B. Leishman, Director-General, Army Medical

Services, on "Health in the Tropics. the Present and the Future"

An appointment is to be made in July of the Busk Studentship for research in aeronautics, and specially in those subjects such as stability problems, meteorological questions bearing on flight, or the investigation of gusts, treated either experimentally or mathematically, in which Edward Busk was specially interested The Studentship is of the value of about 150*l*, tenable for one year from October 1, and is open to any man or woman being a British subject and of British descent who had not attained the age of twenty-five years on October 1, 1924 Application forms, to be returned not later than May 12, can be obtained from Prof. B. M Jones, Engineering Laboratory, Cambridge

GLASGOW.—The degree of Doctor of Science (D Sc) has been conferred on Mr F Y Henderson for a thesis entitled "An Apparatus for the Study of Transpiration under Controlled Conditions"

THE Yorkshire Summer School of Geography will be held at Redcar during the fortnight August 8-22, providing the number of entries is sufficient The School is intended to provide a "refresher" course for teachers of geography which will help them to keep in touch with recent developments, and will include lectures, practical work, discussions, and excursions. Lectures will be given on the principles of human geography, economic and regional geography, the teaching of geography, and on climate Practical work will include the analysis and study of topographic maps and the elements of survey Applications for tickets should be made, not later than May 11, to the Secretary of the Yorkshire Summer School of Geography, the University of Leeds

THE "Spirit of Modern Science Instruction" is discussed in a thoughtful article by Director O W Caldwell of Lincoln School Teachers' College, New York City, in the January number of *School Life*, the organ of the United States Bureau of Education During the past fifteen years dissatisfaction with excessive specialisation in secondary schools has led to the development, after much careful study and experiment, of a type of "general science" course which has been widely adopted. Returns for 1921–22 show that in 13,700 public high schools there was an enrolment of approximately 400,000 students in general science The success of this type of course has been achieved in many schools without any diminution of the numbers enrolled in the physics, chemistry, zoology, botany, and physiology classes, and has changed beneficially the character of the work done in these sciences The point, however, to which the article chiefly directs attention is not so much the importance of science teaching being efficient as the importance of cultivating in the young an appreciation of the proper use of science in modern life, and a determination to make it subservient to the general welfare "Until people do not wish to destroy their enemies or their competitors they must not possess the means or knowledge for doing so. Science courses for all the people must help all the people to interpret science for service, not science for power" To considerations such as these are partially attributable, no doubt, the remarkable efforts that are being now made in the United States in connexion with the "Education Week," and otherwise to promote instruction and training in good citizenship

Early Science at Oxford.

May 3, 1687. An account of ye Solar eclips, May ye 1st 1687, was communicated by Mr. Caswell The Dublin Minutes from Nov. 15 to April ye 7th were read, speaking of a new Engin invented by Mr. Ash to raise water with an inconsiderable Power. They communicated a farther account of ye petrifieing of Lough Neagh;—that a toad was kept for eight mounths in Dublin, notwithstanding ye Opinion that noe venemous creature would live there;—that hares and rabbits grow white by Snow,—that Partriges are generally white on ye Alpes

A discourse was given in to the Society, being a confirmation of Dr. Moline's Observation of ye communication between ye ears of Birds, by Mr Pit

May 4, 1686. A Letter from Mr Grail, Rector of Lassington near Glocester, was read, wherein he gave an account of the little stones called *Asteria*, found chiefly in his Parish, which being put in Vinegar, will move towards one another if they lie long in vinegar they will wast away, but will keep their starre-like figures notwithstanding their diminution

May 5, 1685. A Letter from Mr Will Molyneux gave an account of a new Hygroscope of his invention: it is made of common whip-cord fastened at ye upper end the lower end hangs loose with a little weight annext, and turnes round according to ye degree of moisture in ye Air the turning of ye lower end is mark'd by a tongue or index joyned to ye weight, and playing over a circle in paste-board or ye like, so as that ye weight hangs over ye centre of ye circle

May 6, 1684. Dr Plot was pleased to oblige us farther, with ye sight of a Glow-worm shining in ye middle of ye day This gave occasion to some discourse concerning Lucid Animalls, in which Dr. Bathurst bore a considerable share, affirming, that, in some dissections of Glow-wormes, he had formerly observed, that as soon as ye Insect was cut in peices, ye lucidity disappeared, but it was asserted that even ye peices of a dissected Glow-worm have been known to shine, ye Doctor mentioned ye bones of a Thornback, as remarkable for lucidity.

The Mercury of ye Barometers, haveing been very low, all ye last weeke, and no rain near Oxon, gave suspition that there might be rain at some distance. ye like event haveing been certainly known about a month since This discourse began on ye account of a scheme of ye weather ye last month, taken, and communicated, by Dr Plot

1690. A Project of making all ye high-ways and streets perfectly good and smooth at ye charge of what 3 years expence as ye present amounts to; after which they may be kept in repair for ever with very little charge or trouble by the use of rollers instead of wheels

May 7, 1686. The Minutes of the Dublin Society from Feb 22 to April 26 were read. They gave an account that encouragement being given by ye Lord Lieutenant for forming that Society into a body corporate by the procurement of a Charter, subscriptions for money towards it were made by several.

Mention being made in those minutes of a place between the Tropicks where the *Shadow* goes twise forward upon the dyal, and twise backward in a day, Mr. Caswell sayd that this thing happens some parts of the year in all places between the Tropicks (except under the Equinoctial) upon a horizontal dyal, and in other places that are not in the torrid zone, upon an inclining dyal.

Societies and Academies.

LONDON.

Association of Economic Biologists.—The following were among the papers presented at the Edinburgh meeting on February 26 and 27.—

February 26.—F. A. E. **Crew**: Intersexuality in fowls and pigs. The condition in fowls is classified as (*a*) those in which a functional ovary occurs on the left and an active testis on the right; (*b*) ovotestis on left and active testis or no gonad on the right. The first condition is due to lack of inhibiting power in the ovary, so that the other gonad develops. It is always male. In the second class, there is ovarian disease or some other cause for the change of tissue.—W. G. **Smith**: The relation between hill pasture and sheep grazing. Work carried out at Boghall Farm, lately acquired by the Edinburgh and East of Scotland College of Agriculture, has shown a definite relationship between herbage and the quality of sheep produced. The value of the herbage varies with the nature of water supply. When the water is entirely aerial, the soil is impoverished and acid, and grazing is limited mainly to young growth in early summer. When the herbage is flushed by springs, the soil is less acid, and grazing is continuous. The most constant grazing of sheep is in moist places responsive to phosphates, as shown by the increase of white clover and pluff grass.—W. **Robb**. Hybridisation of oats. Experiments conducted with the view of improving the technique of hand-pollination in oats. Oats are generally self-fertilised and natural hybrids are rare. In a number of pure line cultures of known varieties grown side by side for years, only one hybrid was secured. Oats do indeed flower freely, but apparently *after* self-pollination has taken place. A wide range of artificial hybrids has been secured, but none between *Avena strigosa* and any of the cultivated oats. A difference in the chromosome numbers may explain this failure.—J. W. **Gregor**. Observations on the physiology of reproduction in some agricultural grasses. The work was carried out by the use of paper bags in greenhouses and specially designed pollen-proof boxes in the field. More than 90 per cent. of plants in both Italian and perennial rye grass were found to be self-sterile, and the self-fertile fraction are probably not self-pollinated. A proportion of this self-sterility is due to lack of pollen, only the female organs being developed.—J. M. F. **Drummond** and F. W. **Sansome**: The improvement of swedes and turnips by breeding. Yield and quality are of primary importance, but keeping quality and resistance to finger and toe disease are also important. Problems of testing yield in small field plots and feeding value by chemical analysis have yet to be solved. The value of the "dry matter" percentage as a criterion of feeding value is being reinvestigated. The policy of the Scottish Plant Breeding Station has been that of line selection (pure line method). In beginning work, 1922, strains approximately homozygous in respect of important characters were selected. A number of characters in swedes and turnips proved to be inherited, and enough evidence is at hand to show the possibilities of line selection for the improvement of these roots.—J. **Ritchie**: The control of mussels in sea water-pipes. The method used to prevent the blocking of the pipes at Portobello Electric Station with mussels and other marine growths was described. The problem was serious, for during the five months of maximum growth a layer 2-3·5 inches thick formed inside the 5-foot feed pipe. The water taken in was used in the condensers, and it was found that by raising the temperature, in vacuo, of water that had just been used and returning it through the feed pipes, the growth could periodically be killed and prevented from assuming obstructive proportions.

February 27.—R. S. **MacDougall**. The ox warble flies and their control. Warble flies (Hypoderma spp.) are the cause of a great annual loss in Great Britain alone to farmers, butchers, and particularly hide and leather merchants. Great success has attended the attack on the larvæ in their last instar, when lying in a swelling on their victim's back. From 82 to 90 per cent. can then be killed by (1) tobacco powder and lime, (2) Derris, or (3) sulphate of nicotine, in various proportions.—P. H. **Grimshaw**: The occurrence in Britain of *Hydrellia griseola*. In Britain this fly does no damage though it is widespread, but round the Baltic it has been for a long time a serious pest of barley and oats.—Malcolm **Wilson**. (1) *Rhizosphæra Kalkhaffi* causing disease of spruce firs. The fungus is widespread in Central Europe and has lately been discovered frequently in Britain on the glaucous varieties of *Picea pungens*. Needles of the spruce become pale and purplish and fall off. Stem, etc., become blocked by spores. The disease also attacks Sitka spruce and (on the continent) the Norway spruce. It is spread by spores. (2) The occurrence of *Tuberculina maxima* in Scotland and its effect on the blister rust of the Weymouth pine. Blister rust is so serious a disease of the 5-needled pines in Britain that their planting has practically ceased. *T. maxima* is a parasite of the blister rust, and it has now been found for the first time in Britain. On the continent *T. maxima* does not apparently entirely kill out the rust, but there are indications that under the different weather conditions prevailing in Britain, the parasite may have greater value as a control.

Institute of Metals.—The following were among the papers presented at the annual general meeting held on March 11 and 12.

March 11.—H. T. **Angus** and P. F. **Summers**.—The effect of grain-size upon hardness and annealing temperature. Many heavily worked metals increase in hardness on annealing for a short time at relatively low temperatures, and this property depends, among other things, upon the grain-size that existed at the time of rolling. A coarse grain-size increases this rise in hardness and the range of temperature over which it extends, whereas with a fine grain-size, softening may commence at much lower temperatures. This effect was noted in both pure copper and bronze containing 4·5 per cent. of tin. The recrystallisation temperature of copper is higher in the coarse-grained metal than in the fine-grained. By calculating the area of grain boundary per cubic millimetre of metal from the grain-size, and plotting against hardness, a straight line was obtained, indicating that the hardness varies directly with the area of grain boundary per unit volume of metal.—S. L. **Archbutt**: A method of improving the properties of aluminium alloy castings. The process consists in allowing the molten alloy or metal to cool slowly in the crucible in the furnace until it has just completely solidified; it is then remelted, and may be carefully stirred, raised to the pouring temperature, and cast. Ingoting the metal is not satisfactory, as the ingots cool too quickly, and during remelting are too much exposed to the furnace gases. Passage of an inert gas through the melt during slow cooling and solidification improves still further the soundness of resulting sand-cast bars. The method eliminates a

considerable proportion of dissolved gas and thus reduces unsoundness, and to a considerable extent removes pin-holing.—Ulick R. **Evans**: Surface abrasion as a potential cause of localised corrosion. Previous work has indicated that most cases of serious corrosion are of an electrochemical character; it has been suggested that very severe corrosion may be occasioned by electric currents flowing between a bare abraded portion and the still encrusted area. An experimental investigation has been made regarding the existence of these currents. Sometimes they flow in such a direction as to localise corrosion on the small abraded portion, sometimes in the contrary direction. But they are generally transitors, dying away soon after abrasion ceases. Moreover, the abrasion required to produce them must, in most cases, be sufficient to damage the metal by mechanical erosion also. In the corrosion of zinc by hydrochloric acid, the wiping away of the black scum of residual impurities (lead, etc.) actually diminishes the rate of attack. Commercial (impure) zinc is attacked more slowly than some grades of much purer zinc. Probably "homophase" impurities (in solid solution) behave in the opposite mode to "heterophase" impurities (present as a separate phase).—J. Newton **Friend** and J. S. **Tidmus**: The influence of emulsoids upon the rate of dissolution of zinc in solutions of lead, nickel and copper salts. Emulsoids tend to retard the velocity of such reactions, whether chemical or physical, as involve a change of state from solid to liquid, or vice versa, in one or more of the components. This retardation is, in the main, due to adsorption, a thin layer of the emulsoid collects upon the surfaces of the solid reactants and impedes their chemical activity. The retarding action frequently falls off markedly with rise of temperature.—Denis **Bunting**: The influence of lead and tin on the brittle ranges of brass. The chief effect of lead is mechanical, the brittle range in itself is not affected, but masked owing to the embrittling effect at other temperatures of the lead which segregated as globules at the grain boundary. Tin in excess of the solubility limit produces extreme brittleness owing to the production of the brittle gamma or delta constituent. The effect of tin in solution appeared to be connected with an increase in crystal rigidity.

March 12.—G. L. **Bailey** and R. **Genders**: The density and constitution of the industrial brasses. A reduction of density, due to unsoundness accompanying constitutional change (β to α), occurs in the brasses over a considerable range of composition. The unsoundness is removable either by reversing the constitutional change (as by quenching) or by mechanical compression. Thus heat-treatments, involving quenching of the α β brasses and a small range of the α brasses, may give rise to internal stresses of considerable magnitude. The cracking of heat-treated articles which sometimes occurs appears to be attributable to constitutional volume change rather than to the difference between the expansivities of the different constituents.—A. L. **Norbury**: Note on the effects of certain elements on the electrical resistivity of copper. Values for the increase in the electrical resistivity of copper due to the presence in solid solution of 1·0 atomic per cent. added element are calculated for each of the added elements. The "atomic effects" are small for elements like silver and gold—which are in the same group as copper in the Periodic Table—and are progressively larger as the added elements are farther away from copper in the Table.—Sir Thomas Kirke **Rose**: On the density of rhodium. One specimen was forged up from sponge and annealed but not melted, and the other melted from sponge in the oxyhydrogen blowpipe and forged while hot. The rhodium sponge was chemically pure. The density of the melted specimen was 12·47 in vacuo at 0°/4°, but the other specimen was evidently not free from internal cavities, as its density was only 12·22. Previous determinations have given 12·1-12·6.—Kotaro **Honda** and Ryonosuke **Yamada**: Some experiments on the abrasion of metals. In soft metals and carbon steels the amount of wear is proportional to the frictional horse-power, provided that the coefficient of friction is constant. Under a constant frictional horse-power the amount of wear increases with the coefficient of friction. The effect of the velocity of abrasion on the amount of wear is negligibly small in the range of velocity investigated.

PARIS

Academy of Sciences, March 23.—A. **Haller** and Salmon **Legagneur**: Diketones and mixed ketones derived from the α-mono-nitrile of camphoric acid and of methyl cyanocampholate.—A. **Desgrez** and R. **Vivario**: The estimation of carbon in organic substances. The wet combustion method (sulphuric acid and potassium bichromate) with addition of a short length of red-hot copper oxide is employed. Tubes of potassium ferrocyanide and borax are used to remove chlorine and hydrochloric acid. Test analyses are given.—G. **Claude**: The rectification of the light in neon tubes. If the Geissler tube is made up of a series of wide and narrow sections, the wide portions show the mercury spectrum only and the narrow the neon spectrum.—G. **Friedel**: Ethyl anisal—p-aminocinnamate.—Henry **Scott** was elected corresponding member for the section of botany.—Bertrand **Gambier**: Generalisation of the remainder theorem of Brill and Nœther. Application to groups of superabundant points.—Alexandre **Kovanko**: The necessary and sufficient conditions for the summability of some functions.—V. **Weniaminoff**: Some properties of the limit derivative.—P. **Clerget**: Reconstitution of the explosion motor of 1806 of the brothers Niepce. At the instance of the Service technique de l'Aéronautique, this early internal combustion motor has been reconstructed and found to work perfectly, using lycopodium powder as the combustible.——**Rateau**: Remarks on the preceding communication.——**Barrillon**: Resistance to the passage (through water) of cylinders of revolution turned in a sense perpendicular to their axis.——**Lémeray**: Spherical clusters. The theorem of level surfaces.——**La Rosa**: The relation between colour and amplitude of the variable stars and the ballistic theory. Reply to some criticisms by Ch. Nordmann and C. Le Morvan.—**Le Roux**: The determination of the viscosity coefficient of water in absolute value. The rotating cylinder method was adopted in preference to the capillary tube. Absolute viscosities are given for 5° C. intervals between 0° C. (0·0178) and 50° C. (0·057). The results are in good agreement with those of Thorpe and Rodger.—G. **Reboul**: Study, under reduced pressure, of the radiation emitted by highly resistant bodies traversed by an electric current.—G. **Foëx**: The various magnetic states of an ion. Two specimens of a pure salt (Mohr's salt), well defined from a chemical point of view and placed under identical conditions, may present very different magnetic properties, apparently corresponding to distinct structures of the paramagnetic ion.—E. **Darmois**: The action of boric acid on the rotatory power of malic acid and the malates. The existence of complex compounds of boric and malic acids is clearly

proved; some definite lævorotary compounds of ammonium, sodium, and aniline have been isolated, but the complex dextrorotary compounds are less stable, and, at present, have not been isolated.—P. **Lambert** and D. **Chalonge**: A self-recording micro-photometer with a photo-electric cell. The current from the photo-electric cell is amplified by a triode valve, under conditions securing stability and proportionality. As an example of its use, a negative of the ultra-violet spectrum of the sun is given.—A **Couder**: The action of ammonia on cyanamide.—P **Job**: The spectrographic study of the formation of complexes in solution and their stability.—L **Hackspill** and R **Grandadam**: The reduction of the metallic oxides by the alkaline cyanides. A repetition of Liebig's experiments (1842), using pure sodium cyanide (98·5 per cent) and working in a vacuum. The oxides of lead, tin, copper, and iron give the metal, carbon, carbon monoxide, carbon dioxide, nitrogen, and metallic sodium, the weight of the sodium being practically equivalent to that of the reduced non-volatile metal. Strontium and barium are also reduced and combine with the metallic sodium to form a volatile alloy.—Mlle Suzanne **Veil**: The decomposition of hydrogen peroxide in the presence of nickelous hydroxide. Nickel hydroxide decomposes hydrogen peroxide with evolution of oxygen, but no higher oxide of nickel is formed. The study of the changes in the coefficient of magnetisation shows that nickel hydroxide is not a true catalyst, if the latter be defined as a substance which remains unchanged throughout the reaction. Curves are given showing the changes in the magnetisation coefficient as a function of the time of exposure to the hydrogen peroxide solution.—**Delbart**: Contribution to the study of cold-drawn steels.—Ch. **Jacquet**: The constancy of the yield of the cold spring Velléda of the Royat thermal establishment. The hourly yield of this spring (10,210 litres) has not changed since 1886, and is independent of external meteorological conditions.—Emm. de **Martonne** and L. **Aufrère**: Extension of the oceanic drainage.—F. **Lœwinson-Lessing** and V. **Mitkewitch**: The natural and artificial permanent magnetisation of rocks. A method is described capable of distinguishing between permanent magnetisation produced by lightning and that produced by the terrestrial magnetic field.—Henry **Hubert**: The quasi-permanence of the shape of the meteorological curves in Western Africa.—Pierre **Lesne**: The fauna of the peaty alluvium of the Seine valley to the south of Paris.—René **Souèges**: The embryogeny of the Hypericaceæ. The development of the embryo in *Hypericum perforatum*.—A. **Guilliermond**: New observations on the structure of the Cyanophyceæ.—J. **Nageotte**: The extreme contraction resulting from freezing striated muscle in the frog.—Ch. **Champy** and N. **Kritch**: Analogy of the hormone action of the male and female genital glands on the crest of the Gallinaceæ.—Marcel **Avel**: The vacuome and apparatus of Golgi in the vertebrates. The vacuoles, whether pre-existing or not, which take up neutral red and other stains are, at least in vertebrates, independent of the apparatus of Golgi.—René **Jeannel**: The morphology and origin of the claw of the tarsus of insects.—Jacques **Risler** and Paul **Mondain**: The limit of the antagonistic action of the spectrum and the application of radiations of great wave-length to the treatment of radiodermites and neoplasms.—René **Fabre**: A new method for the extraction of alkaloids or of various organic substances contained in the organs. The organ in a fine state of division is submitted to the digestive action of pancreatine for 12 hours at 50°-55° C. After filtration, the filtrate can be extracted with suitable solvents. Substances such as strychnine, narcotine, veronal, sulphonal, atropine, cocaine, and morphine are stable towards the ferment, but the possibility of the pancreatine acting on the substances sought for must not be forgotten. Compared with the classical Stass-Otto method the process suggested gives higher yields in less time.—A. **Goris** and M. **Métin**: The presence of two alkaloids in *Aconitum Anthora*.—N. **Bezssonoff**: Some data on the nature of the anti-scorbutic principle known as vitamin C. A new process for extracting vitamin C from cabbage juice is described. The crystalline product obtained was analysed (carbon, 45·6 per cent., oxygen, 48·2 per cent., hydrogen, 6·2 per cent.). Daily doses of less than 2 mgrm. of this product prevented scurvy in guinea-pigs.—C. **Gessard**: Pyocyanoid bacilli of the melanogen variety.—Léon **Blum**, Maurice **Delaville**, and van **Caulaert**: The relations between the physico-chemical state of the body fluids and the phenomena of ossification and decalcification.

ROME

Royal Academy of the Lincei, February.—G. Arturo **Crocco**: The degradation of wealth.—Secondo **Franchi**: Observations on the large overthrust Ausonio-Lepino.—Giulio **Supino**: Elastic systems in two dimensions and their relationships to spacial deformation.—Enrico **Fermi**: Intensity of multiple lines.—Francesco **Rizzi**: Rotatory power of fluorinated derivatives of benzene and its homologues as a function of the wave-length.—P. **Bertolo**: Action of iodine on desmotroposantonin; Artemisic acid.—Luigi **Sanzo**: Ova and larvæ of Alalonga (*Orcynus germo* Ltkn.).—Roberto **Savelli**: Transmission of mutations through interspecific hybridisations. Statistics of the first series of experiments.—Nazareno **Strampelli**: Acquisition of new characters in the glumes of blind and eared wheats (*Triticum folliculosum*).—S. **Mandelbrojt**: Generalisation of the calculus of variations.—F. **Sbrana**: An integral equation occurring in the statistical theory of the photo-electric effect.—A. **Carrelli**: Certain effects produced by rotatory motions.—Mentore **Maggini**: Aspect of the spots on Mars observed at Catania during 1924.—Francesco **Vercelli**: The results obtained during the cruise of the *Marsigli* in the Straits of Messina. The investigations on currents are described.—Washington Del **Regno**: Transformation or nickel in the neighbourhood of the Curie point. The temperature at which nickel begins to undergo transformation varies with the physical phenomenon considered. Apparently certain properties exhibit variation as soon as even a small part of the metal passes from one state to the other, whereas others vary only when an appreciable proportion of the material has suffered change.—Giuseppe **Stefanini**: First geological results of the mission of the Royal Italian Geographical Society to Somaliland, 1924.—G. **Rodio**: Pigments of the Florideæ.

Diary of Societies.

SATURDAY, MAY 2

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30.—A. Cheatle: The Mastoid Emissary Vein and its Surgical Importance.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. P. Pycraft: Use and Disuse and their Effect on the Bodily Structure of Animals (II.).

MONDAY, MAY 4.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—R. H. Fowler: A Theoretical Study of the Stopping Power of Hydrogen Atoms for α-particles.—Dr. N. Bohr: On the Interaction of Atoms

during Impacts.—K. G. Emeléus: The Action of the Electrical Counter.—R. A. Fisher. Theory of Statistical Estimation.—W. Burnside: (*a*) On the Idea of Frequency; (*b*) On the Representation of the Modular Group of Order.—J. P. Gabbatt: On Pedal Quadrics in Non-Euclidean Hyperspace.—F. P. White: An Extension of Wallace's, Miguel's, and Clifford's Theorems on Circles.—Prof. H. F. Baker. (*a*) The Stability of Rotating Masses of Liquid, (*b*) Note on a Formula for Lamé Functions.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. E. Naville: Paper.

ROYAL COLLEGE OF SCIENCE ASSOCIATION (at Royal College of Science), at 5.—Prof. E. B. Poulton: Thomas Henry Huxley (Huxley Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—R. C. S. Walters: Water Power Exhibits at the British Empire Exhibition, Wembley, 1924.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. J. Laird: The Nature of Ideas.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. S. S. Brame: Motor Fuels (Howard Lectures) (III.).

SURVEYORS' INSTITUTION, at 8.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.15.—J. E. Hackford: Gas Production from Heavy Oils by Partial Combustion.

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. R. Hutchison: Dr. Samuel Johnson and Medicine.

TUESDAY, MAY 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. D. Adrian: The Interpretation of the Electromyogram (Oliver-Sharpey Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft. Some Effects of Climate on the Circulation (III.).

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.—Annual General Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—F. G. Rappoport: Some Notes on Water Shut-off.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. F. Sonntag: Exhibition of Anthropoid Skulls presenting Features of Interest.—F. Martin Duncan: Exhibition of Cinematograph Films recently taken in the Society's Gardens.—Miss Joan B. Proctor. Notes on the Nests of some African *Frogs*.—Major S. S. Flower: *Contributions to our* Knowledge of the Duration of Life in Vertebrate Animals. III. Reptiles.—C. R. Narayana Rao and B. S. Ramanna. On a New Genus of the Family Engystomatidæ (Batrachia).

INSTITUTION OF CIVIL ENGINEERS, at 6.—Capt. H. Riall Sankey: Heavy-oil Engines. Some Outstanding Questions relating to Large Engines of the Self Ignition Type (James Forrest Lecture).

ROYAL PHOTOGRAPHIC SOCIETY, at 7.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—C. H. Holbeach: (*a*) Some further Aspects of the Theory and Operation of Potter Bucky Diaphragms, (*b*) The Treatment of Coolidge Tubes.

WEDNESDAY, MAY 6.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—E. B. Bailey: The Tertiary Igneous Geology of the Island of Mull.

INSTITUTION OF CIVIL ENGINEERS (jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, Admiralty, War Office, Air Ministry), at 6.—J. Carnaghan: A Standard Code for Tabulating the Results of a Heavy-oil Engine Trial.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Capt. H. J. Round, T. L. Eckersley, K. Tremellen, and F. C. Lunnon: Report on Measurements made on Signal Strength at Great Distances during 1922 and 1923 by an Expedition sent to Australia.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—J. King: The Adulteration of Conserves, with special reference to Pectin and Agar-agar.—J. S. Willcox and H. T. Cranfield: The Influence of Palm Kernel Meal on the Composition of Bacon Fat.—C. H. Ridsdale and N. D. Ridsdale: Points arising from the Analytical Standardisation of British Chemical Standards.—Dr. B. S. Evans: (*a*) A New Method for the Separation and Determination of Tin in Alloys; (*b*) A New Colorimetric Method for the Determination of Cobalt in the Presence of Nickel.—W. B. Walker: The Determination of Small Amounts of Iron by Colorimetric Methods.

ROYAL SOCIETY OF ARTS, at 8.—Air Vice-Marshal Sir William Sefton Brancker. Commercial Aviation.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. H. A. Lorentz: The Motion of Electricity in Metals (Annual May Lecture).

ROYAL SOCIETY OF MEDICINE (Surgery Section) (Annual General Meeting), at 8.30.—Informal Discussion on Acute Small Intestinal Obstruction.

THURSDAY, MAY 7.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10.—Presidential Address.—T. W. Hand: Progress in British Rolling-mill Practice.—A. Hultgren: "Flakes" or "Hair Cracks" in Chromium Steel, with a Discussion on "Shattered Zones" and "Transverse Fissures" in Rails.—At 2.30.—T. H. Turner and J. D. Jevons: The Detection of Strain in Mild Steels.—J. D. Jevons: Strain Detection in Mild Steel by Special Etching.—L. Aitchison and L. W. Johnson: The Effect of Grain upon the Fatigue Strength of Steels.—A. G. Lobley and C. L. Betts: The Influence of Gases at High Temperatures upon Iron, with special reference to the Formation of Blowholes.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Dr. W. Rosenhain and Miss J. McMinn: The Plastic Deformation of Iron and the Formation of Neumann Lines.—Dr. A. E. H. Tutton: (*a*) The Monoclinic Double Sulphates containing Thallium. Thallium Nickel and Thallium Cobalt Sulphates; (*b*) The Crystallographic and Optical Properties of Iodo-Succinimide.—Kathleen Yardley: An X-Ray Examination of Iodo-Succinimide.—*To be read in title only*:—B. Lambert and S. F. Gates: An Investigation of the Relationships existing between Hydrogen and Palladium.—C. G. T. Morison: The Effect of Light on the Settling of Suspensions.

LINNEAN SOCIETY OF LONDON, at 5.—G. C. Robson: Exhibition of the Rare Cephalopod, Spirula.—Sir Sidney F. Harmer: Exhibition of Specimens illustrating Old Age in Cetacea.—Dr. H. G. Cannon: Exhibition of Specimens showing Ectodermal Origin of Muscles in the Crustacean Cheirocephalus.—Miss Andersson: The Genetics of Ferns.—S. L. Moore. A Third Contribution to the Composite Flora of Africa.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. E. D. Adrian: The Interpretation of the Electromyogram (Oliver Sharpey Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. J. Fleure: Prehistoric Trade and Traders of the West Coasts of Europe (I.).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 6.—Annual General Meeting.

CHEMICAL SOCIETY, at 8.—E. H. Ingold. The Tautomerism of Dyads. Part III. The Effect of the Triple Linking on the Reactivity of Neighbouring Atoms.—J. O. Cutter, H. Burgess, and Prof. T. M. Lowry. The Rotatory Dispersive Power of Organic Compounds. Part XVI. Halogen-derivatives of Camphor.—S. Sugden, J. B. Read, and H. Wilkins: The Parachor and Chemical Constitution. Part I. Polar and Non-polar Valencies in Unsaturated Compounds.—J. P. Griffiths and C. K. Ingold. The Tautomerism of Dyads. Part IV. New Evidence of the Tautomeric Mobility of Oximes.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Annual General Meeting.

FRIDAY, MAY 8.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers) at 10.—R. H. Greaves and J. A. Jones: Temper-brittleness of Steel, Susceptibility to Temper-brittleness in relation to Chemical Composition.—D. H. Ingall and H. Field. "Peeling" in White Heart Malleable.—R. L. Smith and G. E. Sandland: Some Notes on the Use of a Diamond Pyramid for Hardness Testing.—J. H. Whiteley: Observations on Martensite and Troostite.—B. D. Enlund: The Structure of Quenched Carbon Steels.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Gilbert T. Walker: Indian Meteorology.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A. N. Krilloff: On Sir Isaac Newton's Method of Determining the Parabolic Orbit of a Comet.—J. Evershed: On Some Measures of the Solar Rotation at Different Levels of the Chromosphere.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—E. Hughes: A Magnetic Bridge for Testing Straight Specimens and an Analysis of the Hysteresis Loop of Cobalt Chrome Steel.—M. C. Johnson: The Experimental Control of Electrically Broadened Spectral Lines.—M. K. Rao: On the Spectra of the Metals of the Aluminium Sub-group.—Prof. A. O. Rankine: Demonstration of the Diffraction of Light by a Spherical Obstacle.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Fourth Report of the Steam-Nozzles Research Committee.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—A. C. Wire: Five Weeks in the High Alps.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.

ROYAL SOCIETY OF MEDICINE (Ophthalmology and Comparative Medicine Sections), at 8.30.—Discussion on Diseases of the Eyes Common to Man and Animals.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. H. H. Dale: The Circulation of Blood in the Capillary Vessels.

SATURDAY, MAY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (I.).

FREE PUBLIC LECTURES.

TUESDAY, MAY 5.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Prof. A. Van Gennep: Some New Methods in the Study of Primitive Man. (Succeeding Lectures on May 7, 8.)

THURSDAY, MAY 7.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.—Sir J. J. Thomson: The Structure of Light (Fison Memorial Lecture).

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. W. E. Dixon: The Cerebro-spinal Fluid, with special reference to Pituitary Secretion.

KING'S COLLEGE, at 5.30.—Prof. A. Cabrera: Prehistoric Paintings in Spain. (Succeeding Lectures on May 14, 18, 21.)—At 6.30.—Dr. O. Vočadlo: The Czechoslovak Republic To-day: Population and Racial Problems.



SATURDAY, MAY 9, 1925.

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MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Anthropology and Administration.

IN the hundred years that have elapsed since the birth of Huxley, anthropology has made greater strides than perhaps any other branch of science with which he was concerned. The measure of his contribution to that advance cannot be gauged only by the results of his purely anthropological work. It is to be judged as much by the spirit and the outlook with which he approached the scientific problems of his day It is scarcely an exaggeration to say that in Huxley's earlier years the study of primitive peoples was little more than a collection of facts, while any attempt at generalisation was usually subservient to some preconceived theory The application of the Darwinian hypothesis to the study of man as a social and moral being, as well as a physical entity, by Huxley and his fellow-workers, diverted that study from the static to the dynamic point of view. This change of outlook, which involved the fundamental conception of the essential unity of the human race and of human culture, laid the foundation of anthropological studies as a science in aim and in method. Looking back on the work of the latter half of the last century, it is easy to criticise the facile generalisations which arose from an unwarranted extension of a purely biological hypothesis, but it opened the way to the conception of continuity in development and the phylogenetic study of anthropological data—a fruitful source of advancement in the study of man and his works.

Huxley's aim as a scientific man was to promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life The practical application of the results of anthropological study, perhaps in a sense more immediate than Huxley intended, has been forced upon the attention of the anthropologist by the march of events to which the growth of the British Empire has been due, and the inclusion under our rule of many millions belonging to the races which, in the main, are the raw material of his investigation. With the Indian Mutiny began a process of change in our attitude towards primitive races which was still going on at the time of Huxley's death, when we were only just setting foot beyond the fringe of tropical Africa, and is not yet perhaps complete. The indifference of the early days of colonisation which led to an appalling mortality among subject primitive populations and in some cases to their extinction, has given way to a conception of responsibility, not merely for their control and government, but also for their development along lines leading to a higher plane of culture.

The history of our relations with primitive races can be written in a few words—indifference, sometimes tempered by hostility, exploitation, protection, and now at last an increasing disposition to accept a system of tutelage. In all the early stages an exception must be made in the case of the great work of the missionaries who, whatever their errors of judgment, toiled wholeheartedly and with single purpose for what in their eyes seemed the good of their charges; in recent years they have proved the valued allies of administrators.

Problems of administration have become increasingly grave and difficult of solution since the War. Leaving aside India and Egypt, from all parts come accounts of unrest, or of an awakening which may lead to unrest, among native populations. The return of troops from active service, the propaganda of political agitators among the more advanced, and the increased prosperity of the individual, as in Uganda since the cotton boom, have contributed to this in varying degree. In Africa in particular these problems have become acute. All credit must be given to both missionaries and administrators who have endeavoured to cope with the evils, political, social, and moral, arising from the process of rapid detribalisation which is going on in certain parts of Africa. They look to education to substitute a controlling influence in place of the old tribal regime.

It is clear, however, that to be effective in securing this end, any system of education must tend to raise the level of the population as a whole, and not merely afford opportunity to individuals of exceptional capacity. Both the Phelps-Stokes Educational Commission and the Advisory Committee on Education in Tropical Africa have recognised the principle that education should be vitally related to the life of the tribe, its religion, its agriculture, its industries, its hygiene, and its recreations. The latter body, in a recently published memorandum, "Education Policy in British Tropical Africa" (Cmd. 2374), points out that

> "the central difficulty in the problem lies in finding ways to improve what is sound in indigenous tradition. . . Since contact with civilisation—and even education itself—must necessarily tend to weaken tribal authority and the sanctions of existing beliefs, and in view of the all-prevailing belief in the supernatural which affects the whole life of the African, it is essential that what is defective should be replaced."

In defining the general character and aim of the type of education the Committee has in view, it is stated that its object *inter alia* should be "the training of the people in the management of their own affairs and the inculcation of true ideals of citizenship and service." The intention of this memorandum is admirable and the aim it states is beyond reproach. It is, however, permissible to doubt whether an anthropologist might not have put the case rather differently. While granting that "citizenship and service" may be the avowed aim of education in a western community, and quite possibly the only aim for whatever people an educational system may be devised, it is somewhat remote from a mentality such as that of an African native, to whom it is quite logical to demand a fee from a Medical Officer by whom he

has been treated or compensation for the time his children may spend in being educated in a school—a mentality which by tradition of generations immemorial knows no constraint beyond the *force majeure* of a primitive belief, a primitive tribal custom, and the power of his chief.

While watching with interest the experiments at Achimotá in the Gold Coast Colony, and at Fort Hare in South Africa, for developing a purely African training for the Africans by themselves, the anthropologist realises the burden to be laid upon the administration, to whom will fall the task of working out the details of a scheme of education on the lines suggested. Experience has shown in Africa and elsewhere the danger of eliminating any detail in a primitive social system which may to the European appear detrimental or otiose The psychological effect of the suppression of head-hunting in New Guinea has frequently been quoted. The mistaken ban on the *lobola* (bride price) in South Africa led to social disaster. In Central Africa the loss of their cattle in certain tribes through the ravages of the tsetse fly has compelled them to take to agriculture, but has produced matrimonial chaos through the destruction of the medium for acquiring a partner in marriage. Examples could be adduced almost without number to illustrate the difficulties and dangers besetting any change made without the most intimate knowledge of the ramifications of tribal custom and belief.

Anthropologists for long have urged that officials who are engaged in administering the affairs of peoples of non-European culture should receive a training in anthropology and its methods. They have pointed out that such training, by enabling them to get more quickly into touch with the mentality of the people over whom they have jurisdiction, would eliminate the mistakes which are inevitable until they have acquired by long experience a sympathetic understanding of their customs and ways of thought. The importance of this as a factor in administration has been enhanced by the difficulties which have arisen since the War, but it will be increased many fold should it fall to the official to be responsible for the modification of tribal custom in such a way that tribal authority may not break down before some adequate substitute can be found.

It may not be out of place to refer to the recent correspondence in the *Times* in which a number of prominent anthropologists expressed in the strongest terms their sense of the importance of the study of primitive races and of the training of officials in such studies in the interests of imperial administration. It was further pointed out that a central organisation was needed at which data relating to these peoples might be collected and collated for study and official use. In indicating the Royal Anthropological Institute as the body most fitted for this purpose, it is interesting to note that they named an organisation of which Huxley was virtually the founder.

Natural Science and Religious Beliefs.

(1) *What I Believe.* By Bertrand Russell. (To-day and To-morrow Series.) Pp. 95. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1925.) 2*s.* 6*d.* net.

(2) *The Religion of a Darwinist: Conway Memorial Lecture delivered at South Place Institute on March 26, 1925.* By Sir Arthur Keith. Pp. 76. (London: Watts and Co., 1925.) 2*s.* net.

(3) *Science and Religion.* By Prof. J Arthur Thomson. Pp. ix + 238. (London: Methuen and Co., Ltd., 1925.) 7*s.* 6*d.* net.

THE fame of most scientific men depends on their positive contributions to some particular branch of science; but Huxley's fame depends mainly on the clarity and fearlessness with which he not only expressed scientific conclusions, but also extended their application to the beliefs popularly held in his time, and particularly to theological beliefs. The smoke of controversy rolled round his writings forty or fifty years ago, and, though some of it has cleared away, it still continues to roll round the subjects on which he wrote. The three short books referred to above are sufficient evidence of this.

In his "What I Believe" Mr Bertrand Russell expresses the view that reality as described in the terms of existing physics corresponds to ultimate reality:

"Given," he says, "the laws governing the motions of electrons and protons, the rest is merely geography—a collection of particular facts telling their distribution throughout some portion of the world's history. The total number of facts of geography required to determine the world's history is probably finite: theoretically they could all be written down in a big book to be kept at Somerset House, with a calculating machine attached, which, by turning a handle, would enable the enquirer to find out the facts at other times than those recorded" . . "Of this physical world, uninteresting in itself, Man is a part His body, like other matter, is composed of electrons and protons, which, so far as we know, obey the same laws as those not forming part of animals and plants." . . . "God and immortality, the central dogmas of the Christian religion, find no support in science." . . . "Fear is the basis of religious dogma, as of so much else in human life. Fear of human beings, individually or collectively, dominates much of our social life, but it is fear of nature that gives rise to religion." . . "The philosophy of nature must not be unduly terrestrial: for it the earth is merely one of the smaller planets of one of the smaller stars of the Milky Way. It would be ridiculous to warp the philosophy of nature in order to bring out results that are pleasing to the tiny parasites of this insignificant planet. Vitalism as a philosophy, and evolutionism, show in this respect a lack of sense of proportion and logical relevance. They

regard the facts of life, which are personally interesting to us, as having a cosmic significance, not a significance confined to the earth's surface." . . . "All such philosophies spring from self-importance, and are best corrected by a little astronomy."

These quotations will give a good idea of the main argument running through the book, which is simply and brilliantly written, and will well repay reading by those who are really trying to understand ideas which, consciously or subconsciously, appeal to many men of science and to a far larger number of persons whose beliefs are influenced by scientific conclusions The close kinship between Mr. Russell's ideas and those put forward by Huxley, and also by Laplace at the end of the eighteenth century, will be evident.

Sir Arthur Keith's "The Religion of a Darwinist" is written with all the charm and appeal to human interest which we are accustomed to find in his popular writings on anthropological subjects. He bases his religion on the fact of biological progress, though he traces that progress to nothing but the "machinery at work in all living things," and he regards that machinery as still omnipotent.

"One can conceive that into one of these primitive tribes, such as hunted over the site where we now meet, there may have been born at occasional times a dreamer who longed for the day when all that was good in the intratribal spirit would leap the frontier which encircled him and his fellows, and spread goodwill and fellowship through all surrounding tribal territories. This was the ideal which issued from Nazareth over nineteen centuries ago Christ's mission in life was to break down tribal boundaries—the fences which Nature had set up with such infinite ingenuity and patience. He sought to make mankind one tribe, and the intratribal practice of mercy the common law of the world. The soldier and the diplomat worked for the same end by substituting force for the sweet persuasion of the Evangelist. How far they have succeeded, and how far they have failed are shown on the present map of the world, and by the present state of international politics. . . They cannot succeed until they have smashed the machinery of evolution—the machinery which has made the world what it now is."

Sir Arthur Keith's conclusion here seems to be different from that expressed by Huxley in his famous lecture on evolution and ethics. Huxley was with the idealists, and boldly exhorted us to smash the "machinery" of evolution. If in this he was not logical, and seemed to be calling in something which on his own philosophy could not exist, is not Sir Arthur Keith less than logical too? Would not Mr. Russell's prescription of "a little astronomy" remove the basis of his religion? Is the evolution of life on this small planet anything but a transient ripple on an ocean of mechanical happenings?

Prof. J. Arthur Thomson's book "Science and Religion" is written from a very different point of view, and starts from the actual existence of religious belief implying "a recognition of a higher order of reality than that reached in ordinary experience." "Its essence is threefold—submission to the Divine Will, some form of communion with the Divine, and a vision of God." The book is a discussion of the apparent conflict between natural science and religion, and maintains that there are no real grounds for conflict, provided that both religious beliefs and scientific beliefs confine themselves to their proper spheres. But there lies the rub: for both natural science and religion lay claim to be representative of the whole of our experience, and though Prof. Thomson has no hesitation in throwing overboard traditional theology wherever it is inconsistent in mere points of detail with natural science, the fundamental clash seems to remain.

Much of the book is devoted to pointing out that the interpretations of any particular branch of natural science are only partial interpretations of what is actually perceived. Physical science, for example, takes no account of such things as beauty, and gives no satisfactory account of life. In face of conscious experience it has nothing to say which throws any light on the connexion of consciousness with physical change.

"There is much to be said in favour of the admittedly difficult view that living organisms emerged from the dust of the earth. If so, and if the world's process is continuous, then there must be in the dust the promise and potency of life. And where life is, mind may be. If the dust of the earth came from the primitive nebula, then in the nebula also must have been more than met the eye. . . We adhere to the Aristotelian idea that there can be nothing in the end which was not also in kind in the beginning. . . . But it is not to this immanent panpsychism that we mean to refer when we speak religiously of the Unseen Universe. The religious refers to a Spiritual order, which can only be religiously discerned. It is the idea of a Creation which was not an event over and done with unthinkable millions of years ago, but remains as an enduring Divine thought."

It is probable that most men of science will be prepared to admit that they do not know what may lie behind the present physical interpretation of the universe But between the world as physically interpreted and the world of conscious experience a gulf is left, so that statements such as those quoted in the last two sentences from Prof. Thomson seem incapable of being brought into any relation with physical interpretation.

During the nineteenth century natural science became almost entirely divorced from philosophy. It is becoming more and more evident that this un-

fortunate position cannot continue if either natural science or philosophy is to throw all the light it is capable of throwing on such questions as are discussed in the three books before us.

For those who take philosophy seriously it is no longer possible to regard the world, except for mere convenience in dealing with limited practical problems, as consisting of "bodies," whether conscious or unconscious, existing independently of one another in space, and subject to a series of independent events in time. The reasoning of Hume and Kant cannot be neglected, and made the interpretations of Galileo and Newton no longer possible as ultimate interpretations. Our universe must in some way be one existence, and not a collection of separate existences, whether these separate existences be regarded as physical bodies or units of sensation.

Space and time themselves do not lie outside the scope of the reasoning of Hume and Kant; and from this point of view the detailed reasoning of the three books under review appears scarcely adequate to their subject. When Laplace swept the heavens with his telescope, or when Darwin swept the remote past of man and other living organisms, neither of these great men of science was escaping from the One Existence manifested in his own perceptions and endeavours. Kant and his immediate successors at least pointed the way towards a deeper rational account of our experience—an account in which æsthetical, ethical, and religious experience have cosmic significance which stands out behind the partial interpretations of natural science.

At the present time it would be as futile to raise a cry of "back to Kant" as it would be, in physics, to raise one of "back to Galileo and Newton." We may safely say that had Kant foreseen the progress of physics and biology since his time, the details of his philosophical writings would have been very different, and his main reasoning would have stood out far more compact and intelligible, freed from the artificial discontinuity which exists between his accounts of physical interpretation and of æsthetical, ethical, and religious interpretation.

It was through his failure to take adequate account of philosophical progress that Huxley fell short on the philosophical side. He never carried with him the philosophers in his wider conclusions. Nevertheless, he took a leading part in clearing away a vast accumulation of harmful theological debris, and he was a fearless fighter for what he believed to be right and true. Those who are firm in the conclusion that the universe is one spiritual universe have good reason to honour his memory.

J. S. HALDANE.

The Living Cell.

The Cell in Development and Heredity. By Prof. Edmund B. Wilson. Third edition, revised and enlarged. Pp. xxxvii + 1232. (New York: The Macmillan Co., 1925.) 36*s.* net.

PROF. E. B. WILSON is the leading figure among the older American biologists—a rare combination of the scholarly mind with the adventurous research spirit. All who know him, whether personally or through his work, will be glad that, in spite of the protracted ill-health from which, alas, he has been suffering for some years, he has been able to crown his scientific career by the issue of this book.

I say book advisedly; for while this purports to be but a third edition of an old work, the second edition was published in 1900, and the lapse of a quarter-century has necessitated not merely radical revision but in most chapters a rewriting of the whole. In its new guise it is a formidable volume—more than twice the length of the second edition—of 1200 pages, and more than 500 illustrations—a fitting companion to that other great American work on the same subject which has recently appeared, the "General Cytology" edited by Cowdry. This latter is a composite work, by many authors; what it gained in many-sidedness it lost in unity; whereas unity of treatment is one of the outstanding features of Wilson's book, which is in no sense a mere compilation, but a work of most deliberate plan and careful execution.

Wilson's own cytological work began in the middle 'eighties: and it is a welcome reminder of the extraordinary rapidity of the rise of this branch of biology to realise that the book is to all intents and purposes a summary of progress achieved in the subsequent forty years. What had gone before had consisted essentially in the discovery first of cells and then of chromosomes, and in the proof of their general and almost universal existence; on these bases is reared the vast edifice of detail here presented to us.

The book opens with a wholly admirable historical introduction, followed by a chapter on general cell-morphology. Then come special chapters on special aspects of the cell—mitosis, reproduction in general, the gametes, fertilisation, meiosis. There follow three general chapters on reproduction and sex in low organisms, on some aspects of cell-chemistry and physiology, and on some problems of cell-organisation. Finally we reach that aspect of the subject which perhaps more than the rest Prof. Wilson has made his own—the relations between cytology and, on one hand, heredity, on the other, early development. A chapter on chromosomes and sex is followed by others on chromosome morphology; chromosomes and heredity; growth, cell-

division and development; and finally, development and heredity. Perhaps "finally" is not the right word, since there is still to come a hundred pages of glossary, index, and (chiefly) list of literature.

On May 4, 1825, Thomas Huxley was born. Wilson's historical retrospect will serve as a forcible reminder of the wonderful progress of our knowledge in the century that has since then elapsed Prévost and Dumas, in the year before he was born, had given the first accurate description of cleavage and the definitive proof that the spermatozoa were the active agents of fertilisation. The cell-theory was promulgated when he was a boy in his 'teens, and by 1855 had assumed the definitive form epitomized in Virchow's aphorism "omnis cellula e cellula." Descriptive histology and embryology had meanwhile been rapidly accumulating facts, and had paved the way for cytology proper Huxley was fifty when Oscar Hertwig proved that the sperm and the ovum each contributed one of the two nuclei that fused at fertilisation; and before he was sixty the essential facts of mitosis had been discovered, and biologists had begun to concern themselves with the phenomena of meiosis. Through the brilliant critical speculations of Weismann, attention was focussed on the point, and before Huxley died, he had obtained a comprehensive view of this amazing microscopic machinery of the chromosomes and of its significance for life in general—a view which we know from his writings afforded the keenest intellectual pleasure to his old age. In the short thirty years since his death, there has come the rediscovery and amplification of Mendel's work, the transformation of the chromosome hypothesis from an interesting speculation into one of the foundations of biology, and the penetration beyond the visible chromosomes to their invisible component units—a penetration comparable to that effected in physico-chemical science by the atomic theory.

It is impossible to criticize a book of the scope and calibre of Wilson's from the point of view of trivial errors of fact or of what the reviewer may consider errors of judgment on isolated points, but a few words may be said about its general treatment and its broad bearings. The sections into which it falls are of rather unequal value. In the first place, there is an almost complete absence of any treatment of histogenesis (save that of the gametes) from the cytological point of view This perhaps does not fall within the scope of the book: but it is a pressing task for some one to undertake The chapter on cell-chemistry and cell-physiology, as the author himself makes plain, is scarcely meant as more than a reminder that these aspects of the subject exist The rest of the book really resolves itself into, first, a general section on the cell and cell-organisation, secondly (and largest), into a treatise on chromosomes, their behaviour, and their relation to heredity and sex; and thirdly, an introduction to experimental embryology from a rather peculiar angle.

The first is a straightforward and excellent account. In the present state of our ignorance on such subjects as the function of Golgi bodies and the mechanism of mitosis, it is impossible for it, building a foundation of established principle, to be more than this.

The third constitutes the most important general work on the experimental analysis of the early stages of development which has appeared since Jenkinson's book in 1909 It will be read with the greatest interest by all who are occupied with experimental biology; and yet, in spite of its treasure of well-arranged facts and its lucid discussion, it cannot be said to provide a wholly satisfactory treatment. In the first place, it is really impossible to separate the early from the later stages of development The attempt had to be made by Prof. Wilson if he were not to trespass outside the limits of cytology, but it has only revealed that the problems here attacked are essentially *not* cytological, but can be treated only as part of a comprehensive science of developmental physiology.

In the second place, the author is writing at a time of great discoveries in the subject—discoveries of a sort which make one's treatment out-of-date between proof-correction and publication. For example, if Prof. Wilson had been able to take account of Spemann's recent remarkable work on embryonic grafting, he could not have continued to lump together the type of predetermination in the amphibian egg before the close of segmentation with that found during and after gastrulation.

During the first period, as we now know, there is a predetermination of axes and gradients only, and the germ (apart from the batteries of specific potencies latent in its chromosomes) contains only raw materials, non-specific from the point of view of future organs: during the second all is changed, and the germ becomes a chemical mosaic of irreversibly-determined regions, under the influence, at present unexplained, of the dorsal lip of the blastopore. True "organ-forming stuffs" are thus present only in the second period: in the first (as Jenkinson's rather neglected centrifuging experiments showed) there exist only crude materials.

Wilson's own researches in the subject had largely been devoted to forms, such as Dentalium, in which true organ-forming materials appear very early. I venture to prophesy that these will all turn out to be cases of *precocious* formation of specific stuffs, brought about as an adaptation to very rapid development into a specialised larva, so that the two stages which are readily distinguishable in the slower-developing Amphibia are here superposed and entangled.

Finally, Prof. Wilson allows himself to follow too readily the morphologist's inclination to pin his faith to "stuffs" and regions, and has consequently been led to under-rate the importance of the graded change in physiological activity emphasised by Child and others.

With the remaining section, however, the case is different. The chapters on the chromosomes will long remain our acknowledged *locus classicus* on the subject. There will naturally be great accessions to our knowledge of the physiology of chromosomes; but as regards their appearance, behaviour, and general significance, it is safe to say that the essential principles have already been discovered; and these are fully and admirably summarised in the book before us Chromosomes exist in all but the lowest organisms; they are often differentiated one from the other, and each is in its turn composed of differentiated units arranged in a linear series: they preserve, if not their individuality, at least their "genetic continuity" (an excellent phrase introduced by Wilson), they are divided equationally in ordinary mitosis, but whole paternal and maternal chromosomes separate from each other at reduction; and they are concerned with the determination of the enormous majority of inherited characters.

Wilson disposes readily enough of Loeb's contention that the egg-cytoplasm, quite apart from chromosomal influence, constitutes the "embryo in the rough," and shows vividly how apparent exceptions to the chromosome theory of heredity have been proved not only to be compatible with it, but also have often become converted into some of its most important supports.

After reading this book with Morgan's "Physical Basis of Heredity" as companion volume, there should be no excuse for those sceptics who wish to deny the chromosomes any importance in heredity whatsoever, or those others who would allow us to believe that the chromosomes are concerned in inheritance, but shrink from the further step—the association of particular chromosomes with sex-determination and the analysis of individual chromosomes into specific genes—which the accurate quantitative work of the last fifteen years has led most of us to take.

The evidence is here marshalled in detail, analysed, discussed. From it issues unescapably the conclusion that the physical basis of heredity (with a few exceptions, such as those of plant plastids) consists of the chromosomes or something contained in them, and that this "something" consists of an orderly series of particulate chemical units, orderly both as regards quantitative proportions and spatial arrangement.

With this, one chapter in biology is closed and another begins. We cannot do better than recommend this book to all who are interested in the chapter which is closing or that which is opening before us. J. S. HUXLEY.

Human Biometrics.

Studies in Human Biology By Prof. Raymond Pearl. Pp. 653. (Baltimore: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1924.) 8 dollars.

THE unhasting, unresting diligence of the great investigator who has been to Francis Galton all, and more than all, that Huxley was to Charles Darwin, makes us forget that "Biometry" is no longer a new subject Prof Raymond Pearl was not one of Prof. Karl Pearson's earliest disciples, pupils of an earlier generation, such as the president of the Royal Statistical Society, are happily still in their time of fullest vigour, and it will be many years before Prof. Pearl can describe himself as a veteran. Nevertheless, he is able to put forth a volume containing the fruits of twenty years' work with the tools forged by Karl Pearson in fields first surveyed by Francis Galton The publisher's advertisement alleges, with more truth than usually found in such documents, that the book will interest twelve not entirely distinct categories of educated men, including biologists, medical men, economists, and mathematicians; the author, with equal truth, says that "a book of this sort can make only such claim for unity as inheres in the *point of view* of its author"

It would indeed be difficult to think of subject-matters more disparate than the mass of the brain studied in the first hundred pages and the law of population growth considered in the last hundred. This, however, is common to both, the faith expressed in Kelvin's words: "When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind."

The subject-matter is arranged under four headings: Part I., "Considering Man as an Animal," contains four papers, the longest that on brain-weights, biometric in the narrower sense of the word as used twenty years ago. Part II., "Biological Aspects of Vital Statistics," although including two chapters, one on mortality and evolution and another on the influence of physical activity upon mortality, of a somewhat speculative character, is again a straightforward application of statistical methods to subjects universally admitted to be within the modern statistician's province. The chapter on the vitality of the peoples of the United States is, in the reviewer's opinion, an especially valuable contribution to knowledge. Part III, "Public Health and Epidemiology," apart from an excellent piece of descriptive statistics on national food consumption, breaks fresh ground, particularly the study of some biological factors in the epidemiology of influenza. Part IV. is devoted to the "Population Problem," and,

as the methods adopted were the principal topic of Mr. Udny Yule's recent presidential address to the Royal Statistical Society, it is scarcely necessary to say that Prof. Pearl's treatment of the problem is interesting and valuable.

Although the arrangement of the book is not strictly chronological, the memoir on brain-weight and the studies of influenza are nearly twenty years apart.

There will certainly be some to shake their heads and regret that Prof. Pearl did not continue in the admirable course of his earlier youth. The memoir on brain-weights is a finished piece of work; the author is familiar with the relevant literature, he has shown good judgment in his choice of data, and has reduced those data in the best way; the problem he essayed to solve he has solved The studies of influenza, on the other hand, are incomplete; statistical indices of dubious import are employed, alternative explanations of particular results are not fully considered, and all the relevant data are not examined. The author has wandered from the path of biometric rectitude. Such might be the judgment of a "safe" man But there will never be any shortage of "safe" men, whether in subsidised laboratories or suburban railway carriages. There will always be plenty of people terrorised by specialists and afraid to venture into a field without the landlord's written permission It is well that Prof Pearl has courage, and will not be deterred by the criticisms of any of the twelve groups invoked by his publishers from still more flagrant trespasses than are recorded in the present volume In twenty years' time, in his next volume of collected writings, he will no doubt modify some opinions he now holds Only very stupid people are always right M G.

Our Bookshelf.

Untersuchungen uber Triphenylmethanfarbstoffe Hydrazine und Indole. Von Emil Fischer. Herausgegeben von M. Bergmann (Emil Fischer: Gesammelte Werke.) Pp. ix+880. (Berlin. Julius Springer, 1924) 9.30 dollars.

THE volumes of Emil Fischer's papers, already reprinted in this series, cover the great groups of natural substances with the investigation of which his name is specially connected—carbohydrates and ferments; amino-acids, polypeptides and proteins, depsides and tannins, and purines. The reprinting of the papers was begun by Fischer himself in 1906, and since his death it has been continued by his friend and collaborator, Dr M. Bergmann.

The volume now under notice is the penultimate of the series, but chronologically it comes first as it contains Fischer's earliest work, beginning with his inaugural dissertation on fluorescein and phthalein-orcin, presented at Erlangen in 1874 Though this deals with synthetic substances it already reveals Fischer's bent of mind towards research on natural products, since it starts by pointing out that, from the beginning of organic chemistry, the minds of chemists have hankered after the investigation of the colouring matters of plants and animals, partly because their industrial applications made them accessible, but more because a knowledge of their chemistry might throw much light on their origin and their relation to the organisms producing them. This thesis was the first of seventeen papers on triphenylmethane dyes, which Fischer published between 1874 and 1904, chiefly with Otto Fischer as collaborator. It was characteristic of him that he was able to keep more than one series of difficult researches going at one time, and while the triphenylmethane work was in progress he began the investigation of aromatic hydrazines in 1875, a research which led to the preparation of phenylhydrazine and thus provided him with the tool which he used to such advantage later on in the investigation of the soluble carbohydrates.

The work on hydrazines led in another direction to the synthesis of indoles, a reaction that is still being discussed and is still bearing fruit and, in view of the increasing realisation of the importance of the indole nucleus in complex biological products, may in the long run prove to be as important as any that even Fischer discovered Chemists everywhere will be grateful for the care with which these volumes have been prepared by the editor and issued by the publishers. T. A H.

The Protection of Birds: an Indictment By Lewis R. W. Loyd. Pp vii+88. (London: Longmans, Green and Co., 1924) 3s 6d net.

MR LOYD'S main indictment of the present system of bird protection is its indiscriminate nature, whereby it is sought to protect all sorts and conditions of birds against the hand of man, without due regard to the effect on bird life as a whole. He points out forcibly and with a great measure of truth that indiscriminate protection may, and often does, lead to the over-abundance of hardy, virile species at the expense of less adaptable kinds As an example of this, he suggests that one result of the wholesale protection afforded to the birds of Lundy will be the gradual extermination of kittiwakes, guillemots, razorbills, and puffins by the herring gulls, which feed on their eggs and young In the same way, he affirms that peregrines and jackdaws have accounted for the chough in its former haunts, the great skua for the whimbrel on the Orkneys and Shetlands, and gulls for the tern colonies on the Farne Islands. The author further argues that natural causes, such as floods and shortage of food, and necessary artificial causes, such as lighthouses, are responsible for more wholesale loss among birds than anything that man can accomplish, and suggests that overprotection among vigorous species may, by bringing about overcrowding and consequent epidemic, cause that very destruction which it is designed to avoid.

Mr Loyd would apparently withdraw protection from such birds as herring gulls, starlings, sparrows, rooks, jackdaws, and little owls, in order that the other birds on which they prey in one way or another may be given a chance to survive. His denunciation of the introduction of the little owl will commend itself to others besides ornithologists. Mr. Loyd takes the opportunity to defend the collector against the calumnies levelled against him by such writers as Hudson and by the Royal Society for the Protection of Birds, and

seeks to show that collectors, far from being responsible for the extermination of species, may be regarded as bird protectionists. Collectors, however, like bird protection, are of two kinds, discriminate and indiscriminate. The latter type unfortunately exists, and no defence which Mr. Loyd brings forward can absolve him from the charges laid against him. It is against this type that the energies of writers and bird protection societies are directed.

Chemical Synthesis: Studies in the Investigation of Natural Organic Products. By Dr Harry Hepworth. (Manuals of Pure and Applied Chemistry.) Pp. xx + 243. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 20s. net.

NOT so very long ago authors of text-books on organic chemistry were in the habit of relegating their remarks on alkaloids, glucosides, tannins, and other natural products to the last few pages of their works, and these were not taken very seriously by either teachers or students. In the last twenty years or so all that has been changed, and there are now monographs in most languages on the more important of these products, and the larger text-books also devote some attention to them. Though information on such subjects is therefore more accessible than it was, Dr. Hepworth has rendered a conspicuous service to chemists by bringing together a summary of what is now known about natural pigments, carbohydrates, tannins, oils and fats, terpenes, polypeptides, simple natural bases and alkaloids. By restricting his attention to the analytical and synthetical reactions, which have been most useful in elucidating the structure of the more important members of each group, he has been able to produce a readable account of the present position of the chemistry of these substances and an indication of the lines on which progress is still being made. There are slips here and there; for example, it is no longer correct to say that carene does not occur in Nature, and that sylvestrene is present in Indian turpentine oil. Atropine, hyoscyamine, pseudohyoscyamine, and hyoscine are not all isomers of the formula $C_{17}H_{23}NO_3$, and the formula $C_{17}H_{21}NO_2$ does not represent scopolamine; but on the whole the book is remarkably accurate and up-to-date. It is also well produced, and graphic formulæ are supplied wherever they are useful. T. A. H.

Histoire des sciences exactes et naturelles dans l'antiquité gréco-romaine: exposé sommaire des écoles et des principes. Par Prof. Arnold Reymond. Pp. viii + 238. (Paris: Albert Blanchard, 1924). 12 francs.

PROF. ARNOLD REYMOND has for many years given a course of lectures on the history of science at the University of Neuchâtel. This course is attended by students in the Faculty of Letters as well as by those in the Faculty of Science, a practice which is worthy of the notice of university authorities in Great Britain and elsewhere. The present book represents that part of the course which deals with the development of mathematics, the natural sciences, and medicine in Greco-Roman antiquity. It is very well written, and shows that its author has not only a complete command of his subject, but also a ready appreciation of the requirements and mental equipment of his audiences. Whilst avoiding a parade of learning, Prof. Reymond gives full references to his authorities for any statement of importance, and the book will thus appeal to all students of the history of science, especially those whose main interests do not lie in this particular field.

It is of course very difficult to deal adequately with such a large subject in the space of 230 pages, and detail has had to be cut down to a minimum. Nevertheless, Prof. Reymond has contrived to be readable, and as a bird's-eye view of the scientific knowledge of the ancient world his book may be heartily recommended. The increasing interest in the history of science which is manifesting itself in Great Britain suggests that an English translation might be well worth publishing. No other book of the size treats the subject with the same skill. E. J. H.

Patents: Invention and Method. By Harold E. Potts. Pp. viii + 160. (London: The Open Court Co., 1924.) 3s. 6d. net.

IN this little book the author has collected a number of papers that he has published dealing with certain philosophical aspects of patent law and practice. Each of the six papers is presented as an application of scientific method and reasoning to the solution of patent problems, or as an attempt at the correlation of patent law with other more systematised branches of learning. This being so, it is not easy to understand why the paper on language and style should have been included, or, for that matter, that discussing the logical problem of definition. Of the first paper, too, the most that can be said is that it affords an ingenious exercise in the use of mathematical symbols. It is when he comes to discuss prediction and invention in chemistry and the influence of patent law on the evolution of research that the author is most interesting and instructive, though his remarks in the latter connexion on the subject of generalisation must be regarded rather as the personal opinion of a well-known patent agent than as an exposition of the accepted practice in this matter. The remaining paper dealing with the principles of scientific method can be commended to inventor and practitioner alike. E. J.

Rivers and Lakes: the Story of their Development. By Martin A. C. Hinton. (Nature Lover's Series.) Pp. x + 182. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1924.) 6s. net.

THE greater part of this book treats of the work of rivers, while a few chapters are added on the origin of lake basins. Much condensation was clearly necessary to compress so vast a subject into less than two hundred small pages, but Mr. Hinton has done his work well and produced a book that is not only readable but, in spite of being strictly popular, is also accurate and full. It was obviously impossible to discuss fully the topic of ice erosion and ice protection, but the main aspects of the problem are indicated, though it would have been well to refer the reader to some of the recent papers on the glaciology of the Antarctic, where ice action on a large scale is discussed. To describe a glacier as "simply a frozen mountain stream," is not very happy, even if the following paragraphs amplify and extend the statement. The volume fully maintains the high standard of the series to which it belongs, but seventeen diagrams is a small allowance for a popular book of this scope.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Self-diffusion in Solid Metals.

THE "sagacity" with which atoms, or groups of atoms, oscillating about fixed points in the crystal lattice, refuse to exchange position with neighbouring atoms, is often regarded as one of the chief characteristics of the crystalline state. On the other hand, numerous cases are recorded in which crystalline bodies, for example, solid metals, penetrate into each other, in which, therefore, a replacement of the atoms of one metal by those of the other takes place. The classical experiments of Roberts-Austen on the diffusion of gold in lead bars are widely known. At a temperature as low as 100° he found the diffusion coefficient of gold in lead to be 2×10^{-5} cm^2 day^{-1}, being thus only about 100,000 times smaller than that of sodium chloride in water. Several cases of interpenetration of solid metals have been recorded since, including the interesting case of the diffusion of thorium in heated tungsten wires, reported recently by Langmuir. But it must be noticed that from the rate at which one metal like gold diffuses in another like lead, no conclusion can be drawn about the velocity with which the atoms change their position either in a bar of pure lead or of pure gold; no conclusion can be drawn on the rate of self-diffusion in these elements.

The idea of self-diffusion was introduced by Maxwell, when calculating the rate of diffusion of gases. The calculation was very much simplified by considering the case in which the molecules of the two diffusing gases had the same properties, for example, the exchange of place of molecules in a column of nitrogen. The use of the radioactive isotopes of lead enabled one of the writers, in collaboration with J. Groh (*Ann. d. Phys.*, 65, 216, 1921), to realise a measurement of self-diffusion in the case of liquid and solid lead, the diffusion in liquids and solids being practically independent of the difference in the masses of the isotopes. For the rate of the self-diffusion in molten lead, namely, of thorium B in molten lead, close to the melting point, the value found was 2 cm^2 day^{-1}. In the solid metal, however, after heating a bar, the upper part of which was composed of radio-lead, for about a year at 280°, and then analysing the lower part with the electroscope, no diffusion could be found. It was, therefore, concluded that the self-diffusion in solid lead is, even at this high temperature, certainly less than 10^{-4} cm.^{2} day^{-1}.

To increase the sensitiveness of the method, we prepared in the present work two thin foils, one of ordinary lead, the other with lead containing thorium B in homogeneous mixture, and pressed these together *in vacuo*. The thickness of the inactive foil was chosen slightly greater than the range of the α-particles to be measured; therefore no scintillations originating from the radioactive lead could be observed when investigating the inactive foil. But, on heating the aggregate of the foils, a diffusion of the active lead into the inactive one took place and the α-particles due to the diffused atoms or their successive products of disintegration produced scintillations on the observing screen. By comparing the number of these scintillations with the number of scintillations produced by the active foil at the beginning of the experiment, the rate of self-diffusion in lead was determined. The following values were found:

$t°$	D in cm^2 day^{-1}	$t°$	D in cm.^{2} day^{-1}
260°	6×10^{-7}	310°	$5{\cdot}7 \times 10^{-6}$
280°	$1{\cdot}5 \times 10^{-6}$	320°	$4{\cdot}7 \times 10^{-5}$
300°	$2{\cdot}5 \times 10^{-6}$	324°	$1{\cdot}4 \times 10^{-4}$

The diffusion rate 2° below the melting point is thus only 10,000 times smaller than in molten lead.

As regards the problem of the mechanism of diffusion in a crystal lattice, it seemed of interest to compare the rate of self-diffusion found in lead foils with that observed in single lead crystals. The method used was somewhat modified, to avoid stresses, which might have distorted the single crystal. Thorium B was collected in a hydrogen atmosphere on the surface of the single crystal of lead, and it was observed whether, after heating, a decrease of scintillations could be noticed. A similar method was recently used by Werthenstein and Dobrowolska, who measured the rate of diffusion of the active deposit of radium in silver, gold, and platinum (*J. de Phys.*, 4, 324, 1923). In our experiments, even at a temperature just below the melting point no diffusion could be detected. We thus conclude that the coefficient of diffusion in a single crystal of lead even at this high temperature is less than 10^{-8} cm^2 day^{-1}. Also, in a lead bar produced by slowly cooling the molten metal, only a very slow diffusion could be observed (about 2×10^{-8}), while in the case of a suddenly cooled bar a coefficient of diffusion as high as 10^{-5} was determined. A lead foil rolled from the material of the single crystal yielded about the same value as the suddenly cooled bar.

The results found indicate that even the slow rate of diffusion observed just below the melting point is not due to an exchange of place in crystals of appreciable size, but in the "amorphous" material, which is found between the crystals and must necessarily show a less regular structure than the material composing the individual crystals, and thus will be more capable of allowing an exchange in the position of neighbouring atoms.

In a single lead crystal, or in a slowly cooled lead bar even only a few degrees below the melting point, it would take longer, possibly very appreciably longer, than twenty years before an average displacement of the lead atoms to a distance of 1 cm could take place. The time would amount to many million years at room temperature.

When investigating the diffusion of two very similar metals like silver and gold, or thallium and lead, into each other, we can expect to find conditions not very far removed from those encountered in the case of self-diffusion. By using a foil of thallium and one of active lead it was found that the coefficient of diffusion of lead in thallium amounts at 285°, *i.e.* 15° under the melting point of the latter, to 2×10^{-5} cm^2 day^{-1}.

On the other hand, when investigating the diffusion of two different metals into each other, much more intricate conditions were to be expected. We determined the rate of diffusion of polonium, which is the highest homologue of sulphur, into both lead foils and single crystals. In contrast to the case of thorium B, the coefficient was found about the same both in the foil and crystal (at 310° $D = 1{\cdot}3 \times 10^{-5}$ cm.^{2} day^{-1}). The atoms of polonium thus loosen the lattice of the individual lead crystals and diffuse as if through "amorphous" lead. In this connexion it may be mentioned that, in discussing the discrepancy between the values of the period of decay of polonium found by different investigators, Mme. Curie has put forward the explanation, that during the long time of observation, the polonium in some cases

diffused into the metal on the surface of which it was collected. Recently, Maracineanu (*C.R.* 176, 1879, 1923), working in Mme Curie's laboratory, has obtained evidence that the apparent period of polonium is appreciably shorter if the lead on which it is collected is heated for a while.

G HEVESY
A. OBRUTSHEVA
Universitetets Institut for teoretisk Fysik,
Copenhagen.

Evolution, and the Age and Area Hypothesis.

DR WILLIS'S assumption that new genera and new species may arise directly by mutation is rather startling to most students of evolution. He supports his contention, chiefly, by the observation that the frequency distribution of genera containing 1, 2, 3 . . species follows a regular, hollow curve, with monotypic genera the most frequent Mr. Yule (Phil Trans Roy Soc B. 403) has shown that assuming (1) that species give new species by chance at an irregular rate, constant on the average and the same for all species, and (2) that species give new genera in the same way, by mutation, then the frequency distribution of size of genus will approximate closely to that observed in Nature, the latter being such that log number of species plotted against log number of

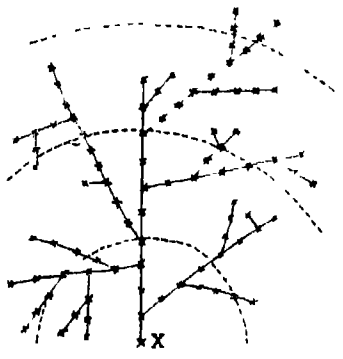


FIG. 1

genera gives practically a straight line. That all genera arise directly by mutation is implied throughout, since they are all supposed to start as monotypes. Finally, Mr Yule concludes that viable specific mutations probably do not occur, in all the flowering plants over the whole earth, more often than about once in thirty years; hence that our failure to observe them cannot disprove their occurrence. This conclusion is disquieting; and we clearly cannot accept this mechanism if we can otherwise explain the evidence adduced for it.

It is natural to try to harmonise Dr. Willis's curves with the usual view that genera arise through the extinction of intervening links, and some insight into this question can be obtained by graphical means

Agreeably with the conventional evolutionary tree, Fig. 1 represents all the species descended from a single species, supposing that none have died out.

We can assume, with some justification, that at increasing distances from the original species (X in Fig. 1) the chance that a species will survive to the present time increases; the survival rate being, for example, 1/3 in the innermost circle, 2/3 in the next, 3/3 in the last. In any area the effect of random extinction of species is shown by numbering the points in the area, taking a random selection of these numbers, in the specified proportion, and deleting the appropriate points from the plan. A distribution such as that of Fig 2 is obtained; an isolated point, or group of points, representing a genus.

In an actual experiment, the original number of species was 884, divided into 12 areas by concentric circles, and about one-half the species were exterminated. First, it was assumed that roughly 1/12 survived from the first area, 2/12 from the second, and so on In a second trial, the corresponding proportions were taken as, roughly, a^{11}, a^{10}, a^{9}, etc The species were

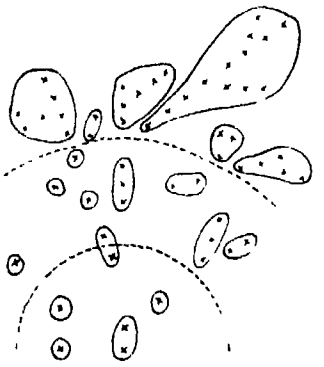


FIG. 2

then classified by assuming that any point, or group of points, separated from all its neighbours by more than a fixed arbitrary distance, forms a genus Any other procedure would simply confront us with the ordinary difficulty of the systematist—where to draw the line between two genera The results for the frequency distribution of number of species per genus, in the two trials, were

No of species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	-21	22
No of genera . (1)	78	41	21	10	3	2	1	1	1	1	0	3	1	1	0	0	1
" . (2)	90	45	21	8	5	4	1	1	1	1	0	1	0	1	0	0	1

The curves of Fig 3 approximate fairly closely to linear form.

It seems likely, therefore, that Dr. Willis's curves accord with the expectation if genera are formed by the dying out of intervening links The scheme I have given is, I am fully aware, open to objections Apart from assumptions inherent in the use of a graphical method, difficulty arises over the distance necessary to give a generic gap, the proportion of

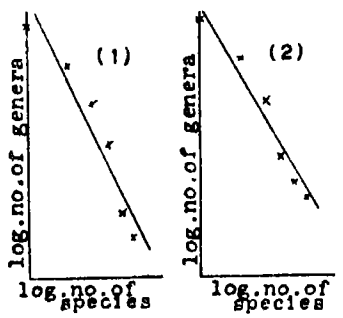


FIG. 3

species surviving from successive horizons, etc Such questions it does not seem profitable to discuss at the present time, especially as similar, and other, objections apply equally to the theory of generic mutation I suspect, too, that the scheme I have given would give similar results with widely different assumptions as to form of the original distribution and the manner of dying out. A. E. WATKINS.

St John's College, Cambridge.

The Growth of Fish.

THE growth of the Brown Trout (*Salmo fario*) can be divided into two distinct phases (*a*) the phase during which growth and maintenance are dependent upon the maternal yolk, (*b*) the phase during which the fish is dependent on external food.

If the eggs are incubated at a temperature of about 10° C the first phase of growth lasts about 100 days During this period the embryo grows at the expense of the yolk At an early stage in development the yolk sac becomes completely cut off from the embryo and the yolk passes, in a soluble form, through the yolk sac wall and is conveyed to the embryo by means of the vitelline veins, as the yolk diminishes in amount the vitelline veins become reduced in size At no period does any of the yolk enter the larval gut The eggs hatch on about the 42nd day, but the process of hatching has no detectable influence upon the growth or the metabolism of the embryo

The respiration of the embryo during the whole of the first growth phase uses up about 4 per cent of the total yolk, leaving about 96 per cent for conversion into the embryo The following figures show the observed rate at which 100 grams of yolk are converted into living tissue

Days after Fertilisation	Wt of Living Embryo in grams		Observed Amount of Available Yolk
	Observed.	Calculated	
T	W_t	W_t	Y
35	8	7	92
40	10	10 5	90
46	17 5	17 5	82 5
50	24	25	76
52	28	28	72
55	35	35	65
60	47 5	46 5	52 5
64	56	56	44
68	64	65	36
71	73	73	27
75	77·5	80	22 5
79	83	86	17
81	88 5	87·5	11·5
82	89	89 5	11
85	92	91 5	8
89	94 5	94·5	5 5
93	96	96 5	4

During the whole of this period two obvious processes are taking place, namely, the increase in the amount of living embryo, and the decrease in the amount of the available yolk During the first 50 days of development the rate of respiration is strictly proportional to the weight of the embryo (650 c c oxygen per kilo per hour), and the rate of respiration doubles itself about every seven days. The observed increment is equivalent to an increase in weight of 10 5 per cent per day After this, the rate of growth falls off almost to zero until the day comes when the young fish begins to feed and the second growth cycle begins

The existence of a second growth cycle is difficult to understand if one assumes with Minot that from the very beginning of development the potential power of reproduction of living tissue is a decreasing entity A more rational treatment of the data is to assume that the rate of growth depends not only on the amount of tissue already present at a particular instant but also on the amount of yolk available. During the very early stages of development the amount of yolk present does not vary very much, and the amount of tissue present at any time is given by the ordinary compound interest formula for a daily increment of 10·5 per cent.

$$T \log 1\ 105 = \log \frac{W_t}{W_o},$$

where W_o is the amount of tissue at the beginning of the development in 100 grams of eggs But if the amount of growth also depends upon the amount of yolk present, then the equation becomes

$$T \log 1\ 105 = \log \frac{W_t \ 100}{W_o \cdot Y_t},$$

where Y_t is the number of grams of yolk in 100 grams of eggs at time T. Putting $W_o = 0\ 225$, the calculated values of W_t are shown in column 3 of the accompanying table

The significance of this equation lies in the fact that there are no arbitrary constants The only value which cannot be checked experimentally is the weight of the embryo immediately after fertilisation If the calculated value for 100 grams of yolk be correct (namely, 0 225 gram), then the weight of living tissue in a single newly fertilised egg must be about 0·0002 gram

It may be mentioned that the absence of data during the first month of development is due to the extreme difficulty of handling the eggs at this stage. Although the calculated and observed figures agree very closely, a correction may be necessary if it is found that the percentage of water in the embryo varies from that found in the yolk at different stages of development

The daily percentage increment during the early stages is greatly affected by temperature, so that the absolute size of the embryo at any time during the first growth phase is determined by the amount of living tissue in the newly fertilised egg, the amount of yolk present, and by the temperature.

Data concerning the second growth phase are not at present available, but it seems quite clear that the quantity of food available plays a very important part in determining the rate of growth, so that the weight of a fish is no criterion of its age. The effect of temperature during this phase is also much less marked, which indicates, possibly, that the potential activity of the living tissue is subordinated to some factor which is not affected by temperature, *e.g.* the amount of available food It will be of interest to see whether the relative rate of growth during this growth phase is comparable to that during yolk-sac development when the relative amount of food available for growth is the same in the two cases

It may be noted that the above suggestions deny any real meaning to such an expression as "a decreasing coefficient of growth." The alternative view is obviously more in harmony with the phenomena of tissue culture and the healing of wounds, although it is not suggested that these things are the result of an increased food supply They show, however, that the rate of growth of a whole organism has no obvious relationship to its potential capabilities of growth

J. GRAY.
Zoological Department,
Cambridge, April 17.

Formation of Waterspouts.

AN interesting observation of a waterspout is reported in the *Marine Observer* of April. The observation was made by Capt. G. Park, of s.s. *Risaldar*. To quote his words: ". . . The waterspout appeared to be semi-transparent, containing dark irregular masses or shapes. By selecting one or any

mass I counted two seconds for this to revolve and which gradually eased until, when close to the cloud, the same mass revolved once in ten seconds "

This is, I believe, the first occasion on which the period of revolution of a spout has been definitely observed.

The speed of rotation agrees approximately with the velocity put forward from theoretical considerations by Mr. F. J. W. Whipple in the *Meteorological Magazine* for February 1921, but the velocity entailed with this speed of revolution is very high It would be about 20 m./s if the spout were 40 feet in diameter, but Capt. Park specially states that this spout was particularly thick and would probably have considerably exceeded that figure.

It is difficult to conceive how so strong a velocity of wind can be generated, especially when it is

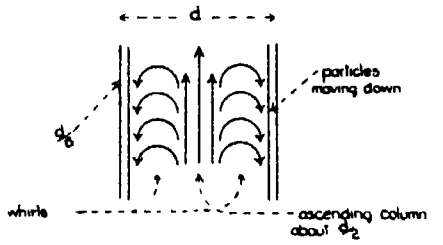


FIG. 1.

recognised that waterspouts most frequently form when the wind is very light (force 1 or 2)

The theory, which is, I believe, most commonly held, that waterspouts are the result of eddies formed between two currents of air, does not seem to meet the case entirely, for it implies that the two currents are of great depth, since waterspouts are often of a greater height than 3000 feet, and are seen forming in the cloud while a corresponding disturbance is observed in the face of the ocean. Also, if they were merely formed in a similar manner to the eddies in a mill stream, one would expect to find them in strings of half a dozen or so instead of the frequent isolated instances.

There must, therefore, be a further condition necessary for the formation of waterspouts. It seems that this condition is probably their association with cumulo-nimbus cloud and violent convection, an association which has not been sufficiently emphasised in their discussion.

There are observations in which the ascent of waterdrops in the centre of a partially formed spout has been seen. For example, one made by Mr V. H. Rozier from s.s *War Hermit* in the Indian Ocean, in which careful observation showed a section of the spout to be moving as shown in the accompanying diagram (Fig. 1), with the ascending column occupying about a quarter of the horizontal section of the spout.

It seems that this convectional property of the central core may be an important feature of the formation of the spout; for, if the lapse rate beneath a cumulo-nimbus cloud were approximately adiabatic, and a patch of air of slightly higher temperature were found near the sea surface, it is conceivable that this warmer air would break through and penetrate up to the cloud. Within the cumulo-nimbus cloud convection will be taking place, and beneath it there will be currents of air drawn into the cloud and expelled from it. By the principle of the conservation of angular momentum, as these currents of air are sucked into the elementary vortex formed by the ascent of the patch of warmer air, they will increase the velocity of rotation until a complete spout is formed by the lowering of pressure at the centre of the whirl

It is significant that waterspouts are very transitory, only lasting for about 15 minutes, which would seem to be the time taken for the warm air to be exhausted

C. S. DURST,

2 Abbey Gardens, N.W 8

Chromosomes in Avena.

WINGE (*Hereditas*, 5, pp 241-286, 1924) has recently shown that irregular chromosome conditions, somewhat different from any previously reported, occur in certain aberrant forms of wheat A cytological study of " false wild oats " begun here last summer has shown chromosome conditions in at least one homozygous strain of this " fatuoid " form of *Avena sativa*, L, to be very similar in many respects to those reported by Winge for a homozygous " speltoid " form of wheat

More than thirty plants have been investigated from a strain of homozygous fatuoid oats of the white-seeded, spreading-panicle type. The reduction-divisions of the pollen-mother-cells appear to proceed normally in the majority of cases, but the following irregularities occur with apparently significant frequencies ·

(1) In diakinesis, instead of the normal 21 pairs, there may be (*a*) 19 normal pairs and one ring, or figure 8, or other combination of four chromosomes; (*b*) 18 normal pairs and two rings, or other combinations of three chromosomes each.

(2) The heterotypic mitosis often proceeds very irregularly. Precocious chromosomes are found at the poles before the remainder have left the equatorial plate. Loops of three or four chromosomes are of common occurrence. Odd chromosomes may be found lagging behind the others during the anaphase, but as they usually arrive at the poles in time to be included in the daughter nuclei, micronuclei are formed only very rarely

(3) It is believed that unequal numbers of chromosomes are sometimes distributed to the two poles, but owing to the lagging it is very difficult to determine this with certainty

(4) A large proportion of the pollen has been found to be abortive

(5) The microspores are frequently arranged in rows of four or other unusual tetrad formations.

The reduction-divisions of *Avena sativa*, L, and *A. fatua*, L, have been found to proceed with almost diagrammatic regularity in all cases examined. Numerous counts have shown 21 to be the haploid chromosome number in both species, as reported by Kihara (*Bot Mag*, Tokyo, 38, p 95, 1919) This is opposed to Nikolaewa's report (*Bot. Abs* 12, p 403, 1923), of 48 as the diploid number in the root tips

Winge's theory of the origin of a speltoid form of wheat through faulty conjugation causing an excess of certain chromosomes and a deficiency of others, with the retention of the normal total, may prove to be applicable to this fatuoid form of oats Particularly attractive is Winge's assumption that, on account of their common origin through polyploidy, the exchanged chromosomes are sufficiently similar to conjugate normally in the majority of cases, but sufficiently dissimilar to cause fairly frequent irregularities. The genetic behaviour of fatuoid oats is, however, not exactly parallel to that of speltoid wheat.

Before any theoretical conclusions are advanced concerning fatuoid oats, the investigation of a number

of very different types of both heterozygous and homozygous forms recently obtained from various sources will be completed. C. L. HUSKINS.

University of Alberta,
Edmonton, Canada,
March 19

Pinhole Photography.

WHILST the design of the photographic lens has received so much attention of recent years and its performance has reached such a high state of perfection, the possibilities of the simple "pinhole" camera are apt to be overlooked and forgotten. The accompanying photograph (Fig. 1) of the Royal College of Science, which I have taken recently by means of the "pinhole" method, may therefore be of interest to readers of NATURE. The following are particulars of the photograph:



FIG. 1.—Pinhole photograph of the Royal College of Science, South Kensington.

Distance of plate from aperture, 8 cm.

Diameter of aperture (using Abney's formula), 0·35 mm.

Exposure (sun being obscured by cloud), 7 minutes.

Angle subtended by extremities of building, 78°.

The photograph shows that for architectural subjects (where wide angle work is necessary) the "pinhole" still stands unrivalled.

B. K. JOHNSON.

Royal College of Science,
South Kensington,
London, S.W. 7.

The Choice of Wave-lengths for Achromatism in Telescopes.

REFERENCE to my paper on the above subject was made by Prof. Townsend Smith in NATURE of October 11, 1924, p. 536, and my reply appeared in the issue of November 1. Although fully endorsing his findings, writing then as I did from Cornwall, I was unable to go much further. I have now returned to my laboratory here.

Prof. Smith pointed out that, in order for the minimum focal length to be at 560 $\mu\mu$ (by which I think he meant line A at 560·7 $\mu\mu$), instead of combining lines D and E it would be necessary to find a line slightly less refrangible than D for such a combination, and that this line should have for wave-length 600 $\mu\mu$.

On returning here I looked this up in Dr. Marshall Watt's "Index of Spectra." I soon found at 600·3 $\mu\mu$ a very fine antimony line marked 10 s.c., that is, with a power of 10 (the highest) sharp and clear. Placing poles of metallic antimony in my spark forceps, I viewed this line through a flint prism in one of my spectrometers. I found it to be admirably adapted for any measurements of refractive index.

Although I myself think the difference between line D (589·7 $\mu\mu$) and this one (600·3 $\mu\mu$) small when small instruments are concerned, in the case of large telescopes, and where computers wish great accuracy, I can strongly recommend effecting achromatism by equalising focal lengths for this antimony line and the E line, with line A at shortest focal length.

J. WILLIAM GIFFORD.

Oaklands, Chard, April 5.

The Teaching of Evolution in the United States

THERE appears in the recent translation of Kammerer's "Inheritance of Acquired Characteristics," by A. Paul Maerker-Branden, the following statement:

"Unfortunately, the so-called 'fundamentalists,' led by William Jennings Bryan and clergymen of different denominations—it seems unbelievable, but it is the sad truth—have succeeded in excluding evolution of man from the curriculum of the schools of North Carolina and Kentucky."

This statement is in part, at least, erroneous. Both of these States have recently had bills presented in the legislature to prohibit paying the salary, from State funds, of teachers presenting the theory of evolution as a fact. In each case the bills were defeated; in North Carolina by a vote, as reported by newspapers, of 64-46. Furthermore, the matter was voted on in North Carolina after the publication of this book. The vote in Kentucky was taken a couple of years ago and was closer.

This statement is made in order to "keep history straight."

BERT CUNNINGHAM.

Duke University,
Durham, N.C., U.S.A.,
April 18.

A Curious Survival.

IN the days of Galileo, medieval objections to experimental evidence and direct observation were prevalent. Jupiter's satellites, for example, were regarded as trivial deceptive appearances, not worth the trouble of looking at; and one argument against their reality was that they would be useless, and therefore could not exist.

It is interesting, though surprising, to find quite similar arguments still in use, and regarded as at least forensically valid to-day; and those who are concerned with the dissemination of scientific method and interest among educated classes, such as the British Science Guild, would find it instructive to read Sir Herbert Stephen's letter to the *Times* of Saturday, May 2, p. 8.

OLIVER LODGE.

Paris, May 3.

The Pigmentation of Animals.[1]

By Prof. JOSEPH BARCROFT, F.R.S.

THE hue which a person presents depends upon two factors, to denote which no precise words exist, but which may be represented by the general terms *pigmentation* and *complexion*. In man these are quite distinct, and for that reason it is best to start with the consideration of the human skin, and from it to work backwards through some of the more primitive forms of life.

First, then, to obtain a clear idea of pigmentation. It consists in the laying down of a definite deposit of coloured substance in a definite layer of the skin. The pigment is laid down as a more or less uniform covering, it is in the deepest layer of the epidermis, and this fact alone suggests considerations which demand some reflection. "The deepest layer of the epidermis," or Malpighian layer, is that from which all the other layers grow. Its cells are in constant division and the offspring of each segmentation, or the daughter cells, all gradually work their way outwards, taking on certain characters at specific parts of their journey, and, therefore, as all the cells move outwards uniformly, endowing the successive layers of the epidermis with the characteristics proper to the advancing age of the cells.

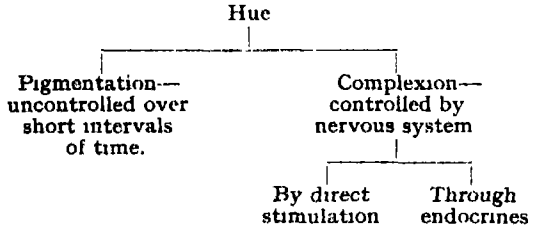
Although the whole cell moves outwards and ultimately drops off, only the innermost part of the epidermis is pigmented (*i.e.* coloured with the black substance melanin). As an Indian student at Guy's Hospital once said: "We Indians do not shed our melanin." I have never seen a blister on the skin of a negro, but as I understand the mechanism of a blister it is as follows.[2] The lower layers of the epidermis are, like living tissues generally, pervious to water. The upper ones are, in comparison, water-tight. The lower layers become injured and inflamed; thither water is drawn, as to all inflamed areas, and because it cannot get away through the water-tight covering on top of it, the water forces up the cover from the layers beneath. If my conception of a blister is correct, it would follow that the portion of the skin above the blister on a negro would be colourless like our own, whilst that beneath the blister would be pigmented.

So much for pigmentation. To pass to complexion. By complexion I understand that element in hue which is variable from time to time, the element to which such words as "pale," "fresh," "ruddy," "sallow," "blue," "cyanotic," etc., apply. These words all have reference to the amount and nature of the blood which can be seen through the epidermis. Unlike pigmentation, the pigment involved is not melanin but hæmoglobin; unlike pigmentation, the part of the skin involved is the dermis not the epidermis; unlike pigmentation, the impression of hue is not due to a uniform layer of colour but to the integration of minute vessels; and, most pre-eminently unlike pigmentation, complexion is something which varies from moment to moment, which reflects the physical condition and the mental equilibrium of the individual.

Complexion then varies (*a*) with the thickness and consequent opacity of epidermis, through which the dermis is seen; and (*b*) with the calibre of the various vessels, arteries, capillaries, and veins of the underlying dermis. Of the veins we know but little as yet; of the capillaries much has been learned within the last six or seven years, and the following table, gleaned from the writings of Prof. Krogh, will give an idea of the relation of the colour and temperature of the skin to the calibre of the arteries and capillaries.

Calibre.		Skin	
Arteries	Capillaries.	Colour	Temperature.
Shut	Shut	Pale	Cold
Open	Shut	Pale	Warm
Shut	Open	Blue	Cold
Open	Open	Red	Warm

Complexion is the expression of the play of the nervous system—in particular the sympathetic system—on the blood-vessels of the skin, but the nervous system can assert itself in two ways, first by direct action, *i.e.* by impulses passing along the fibres which directly supply the blood-vessels; and secondly, by indirect action; *i.e.* by stimulation of one or other of the endocrine glands which in turn secretes an active material into the blood. This material, when it is brought to the vessel wall, affects its calibre. We obtain the following scheme, then, for the factors which influence the colour of the human skin.



Passing from man to the lower mammals we encounter a mechanism which dominates the situation, namely, the growth from the skin of hair. Hair is an outgrowth of the very part of the epidermis which in the negro is pigmented, and therefore the pigment in the hair is of the same order of things as that in the skin. In fact the question arises, quite naturally: "In an animal, which has coloured spots on a white ground, is the colour of the hair on the spots merely the expression of a corresponding pigmentation of the Malpighian layer of the skin from which the hair grows?" If you shave a spotted cat, it is a spotted cat still. But if you go further and cut sections of the skin, there appears to be no pigment in the Malpighian layer; the pigment is confined to the hair roots and the black colour of the spots is due to the visibility of the hair roots, through the epidermis. In the same way the pigment of the scalp of a European, though his hair be jet black, is

[1] Substance of four lectures on "The Colour of the Animal Creation" delivered at the Royal Institution on February 10, 17, 24, and March 3.

[2] In this connexion I came across an interesting example of the ignorance of learned persons on simple matters. Wishing to assure myself of the correctness (or otherwise of the above view, I asked nine specialists, all of them medical men who had studied blisters, whether the seat of the blister was as I have described it, or, alternatively, was between the dermis and the epidermis. Of the nine, three took the latter view and six the view as given above. We consulted a number of pathology books which were at hand, but without gaining any further enlightenment.

confined to the hair. Presumably you could "change the spots" in the case of the leopard by pulling out all his hairs. But it is not so in all animals Thus on the spots of the guinea-pig- and, I believe, of the Dalmatian hound--the Malpighian layer of the skin itself is pigmented, and it would look as though this were the more primitive and less specialised condition.

At a superficial view, it might be thought that, the skin being covered with hair, no question of complexion could arise, but this is not altogether so. Complexion, *i.e.* the variable changes in appearance wrought by the nervous system, changes its ground. In animals and birds, the nervous control of the position of the hairs and feathers respectively is a very real affair. In man it is negligible. We talk of our hair standing on end, but the actual phenomenon is not one of great consequence. In animals it is otherwise, and stimulation of the endings of these nerves which are responsible for the lie of the hairs--whether direct or endocrine—may alter the whole appearance of the animal

One cannot pass the mechanism of pigmentation without some inquiry into its chemical basis: and here we are under a great debt to the late Hulu Onslow, who devoted the last years of his life, recumbent as the result of a severe accident, to the study of the chemistry of animal pigmentation.

Put briefly, many of the phenomena are due to melanin, of which mention has already been made. Melanin itself is produced by the oxidation of one of the most common products of digestion, tyrosine, a colourless crystalline material. The oxidation may be partial or complete; in the former case a reddish pigment is formed, in the latter a pigment which appears black in sufficient concentration, but in a dilute form is more or less yellow or brown. The oxidation of the melanin is wrought by a ferment, tyrosinase, and should it not occur, the failure may be attributed to one or two reasons—(*a*) the ferment is not present, and (*b*) the ferment is prevented from doing its work by some third substance which overrides it. Either of these circumstances may occur and therefore there are two fundamentally different forms of whiteness. The first, due to the absence of ferment, is albinism; the second, due to the presence of an anti-ferment, is dominant whiteness of the ordinary kind, in which the eyes are pigmented. How different these two forms of whiteness are is shown by the way in which they are inherited If an albino rabbit is bred with a pure black, the first generation are all black. If a rabbit with the anti-ferment is bred with a pure black, the first generation are all white

In the chameleon, and more simply in the frog or lizard, is to be seen the complete fusion of pigmentation and complexion. The pigment is to be found in definite cells in the skin, as is the case in the negro. These cells do not, however, form a complete integument, and to these very cells the cutaneous nerve fibres are attached. The colour which the animal presents appears to depend on whether the pigment is diffused throughout the whole cell, in which case the animal is dark, or, alternatively, is concentrated in one locality, in which case the animal is light Here I must acknowledge a debt of gratitude to two former colleagues, Dr. Alfred C. Redfield and Dr. L. T. Hogben, from one or other of whom I have gleaned most of what I know. Their work has dealt chiefly with the control of pigmentation by the nervous system, and has shown, in the animals which they have studied, how important is the endocrine factor. In a frog it is only necessary to inject a small quantity of pituitary extract in order to diffuse the pigment throughout the cells in the skin (melanophores), and so make the whole integument darken. In the lizard the same effect is produced by injection of suprarenal extract. In the chameleon the mechanism is more complicated because the pigment cells are more diverse in kind It must not be supposed that a chameleon can present itself in all the colours of the rainbow. Of two animals which I had the opportunity of observing for about a year, one passed through all shades of brown from a light cream to something short of black, the other through the shades of green from a pale apple colour to a colour so dark as to be barely tinged with green. Let us take the case of the brown chameleon In the light of modern knowledge, two kinds of cells in its skin may be considered as being the most important. Of these, one kind, the most superficial, were yellow, and probably changed little in colour; the other kind were situated behind the yellow ones, making a background for them. These latter were the true melanophores, and they sent tendrils towards the surface which surrounded the yellow cells. The melanophores were susceptible of endocrine action, presumably having nerve endings on which the endocrine substance could act. When the animal darkened, the black pigment in the melanophores, which hitherto had been localised in small areas, became diffused through the cells, pushing into the tendrils, at once tending to obscure the yellow cells from in front and to provide a background which could be seen through the yellow cells.

Why and when does the chameleon change its colour? The tradition is that it takes the colour of the ground on which it is. This tradition I never could verify, though I well remember an occasion on which the green chameleon got lost on a vine and was very difficult to find. It may be that in our climate chameleons are not very sensitive; just as in the Arctic we might not react very readily to the finer alterations of environment. The fact, however, that my family could make their chameleons darken by annoying them is all in line with the knowledge that their tint is ruled by their nervous systems, as is the human complexion.

Though such factors as heat and cold, light and darkness and mental condition play a large part in the colour changes of the animal creation, it is not intended completely to rule out the idea that animals can simulate the background on which they are placed apart from changes in temperature and illumination. The most remarkable examples of the way in which fish can simulate the backgrounds on which they are placed are proved beyond dispute. A flounder on a dark background will become dark, on a light background it will become light, on a speckled background it will become speckled. Further than this it cannot go; it cannot, for example, assume stripes or definite pattern out of sympathy with its background; and this ability to modify its colour is directly under the control of the actual nerves which go to the skin. It is not a roundabout endocrine mechanism. Cut the nerves

going to a particular cutaneous area, and that area loses its power of simulating the background on which the fish is placed. Here at present the matter must be left until we attain to a more perfect knowledge of what protective coloration really means, for it must always be borne in mind that the object of protective coloration is to save the animal from its natural enemies, and not to save it from us.

What assumption is there that because a fish looks to us the same as the ground on which it lies, it will be similarly protected from its marine adversary, or that it may not be invisible to its enemy though appearing to us to be of a colour very discordant from its background? That such considerations are by no means fantastic may be shown by a very simple experiment. In our own eyes there are two complete mechanisms for the perception of colour; one resides in the rods of the retina, the other in the cones We can use either at will, and they see colours quite differently. The cones we use in a light of ordinary intensity, the rods in a dim light. The room is completely dark, there is a blackboard on which are pinned two paper fish. Let in a little daylight—just a little—one fish is seen, it is greyish; a little more light is let in, it becomes brighter, and so with more light until there is some suggestion of the second fish, by which time the first is easily seen. Turn on the electric light, the second and invisible fish at once flashes out, a bright red, whilst the first, which is less obvious, is a royal blue The switching on of the light transferred the seat of vision from the rods to the cones, but the colour scheme—red on black—which formed a complete protection to the rod-vision became dangerous when the cones were invoked We need more knowledge of what life looks like to enemy-animals before we can discuss further the adequacy of the colour schemes of protectees.

The Hebrew University in Jerusalem.

THE inauguration of a new university is an event of interest to all engaged in academic and scientific pursuits, but the opening of the Hebrew University on Mount Scopus, by Lord Balfour, on April 1, aroused more than usual interest, not only among Jews but also among all civilised peoples. The new University is yet in its infancy. At present, a small but well-equipped chemical department is in existence, a micro-biological department is in preparation, a department of Jewish studies is in being, while active preparations are being made in connexion with the Einstein Institute of Physics and Mathematics, the foundation stone of which was laid on Thursday, April 2, by Sir Arthur Schuster. Nevertheless, in spite of its present smallness, the opening of the University was the occasion of a remarkable demonstration of enthusiasm on the part of world-wide Jewry, as well as of sympathy from a large number of universities and learned institutions, which were either represented at the opening ceremony or sent messages of greeting and goodwill.

Palestine is in the process of rebirth, and in all parts of the country there are evidences of great activity in agriculture, industry, and commerce, particularly on the part of the Jewish immigrants who are making Palestine their national home. The University and its associated institutions, like the excellently equipped Technical Institute at Haifa, the Botanical Research Institute at Tel-Aviv near Jaffa, and other institutions of a medical character, must evidently serve the country in the sense of directing the various economic developments. But the most important function of the University, and the function that appeals most to Jews as well as to non-Jews, is to constitute the intellectual centre of world-wide Jewry.

Jews were almost completely excluded from European university life until the nineteenth century, so that Jews figured scarcely at all in the scientific progress of the seventeenth and eighteenth centuries. But as soon as the universities of Europe were opened to Jews, members of this race began to play a rôle of considerable importance in the academic life of civilised humanity. Everybody interested in any branch of science can illustrate this statement for himself with reference to his own subject, and often he will be surprised to discover that men whose names stand in the front rank of the workers in the subject are of Jewish race or origin. In this connexion it is of interest to refer to the statement made by Lord Balfour at the opening ceremony, when he mentioned the remarkable fact, that the three great theories which have aroused the most general interest in all circles and in all countries, namely, the psycho-analytical theory, the creative evolution theory, and the theory of relativity, are all due to Jews, namely, Freud, Bergson, and Einstein.

While Jews have thus as individuals contributed to the intellectual progress of mankind, it nevertheless remains a matter of speculation as to how much Jewry as a body can contribute to the scientific life of humanity It will be of the greatest interest to watch sympathetically the young institution on Mount Scopus, and observe in what measure it will tend to increase human resources in the scientific field

Judging by the very considerable participation in the opening ceremony by the great universities of the world, it seems that there is a considerable amount of confidence in the success of the new University in Jerusalem. So far as Great Britain is concerned, the Universities of Oxford, Cambridge, London, Manchester, Liverpool, Leeds, Edinburgh, Aberdeen, etc, sent representatives to the opening ceremony, while messages of cordial greeting were received from other universities. The Royal Society, the British Academy, and other such bodies, were represented in person, and many others sent cordial wishes.

In the opinion of most people competent to judge, this confidence is not misplaced. In the first place, there can be no question of the existence of a sufficient number of distinguished Jewish men of science to direct the work of the new University. The appointments are being made with very great care and circumspection, and it is gratifying to be able to say that only considerations of eminence in research are allowed to govern the choice of professors and their colleagues.

In the second place, the Hebrew University in Jerusalem is not making the mistake that many lay advisers and critics wanted it to make, of embarking without delay on the task of training doctors, lawyers, engineers, teachers, etc. Palestine itself cannot absorb large numbers of such professional men, but more important still, professional men receiving diplomas

from any institution will find these diplomas of very limited value, unless the institution has first acquired a prestige by the eminence of its teachers and examiners. The University of Jerusalem is therefore at present directing its energies to the creation of schools of research, by the provision of modern equipment and the appointment of able researchers. This policy means slow but sure progress. There is no intention of making a post-graduate university like some institutions in the United States. The intention is to commence with advanced and post-graduate work, leading up to the development of a fully-equipped teaching and degree-giving university

There are one or two features of the University in Jerusalem which cannot but arouse discussion and even doubtings. The language of instruction in the University is to be Hebrew. There can, of course, be no objection to this on the ground that outsiders will not know Hebrew, because similar objection can be raised to Greek in Athens or to Spanish at Madrid, even to English at Cambridge. The real question at issue is whether the language of the Old Testament is suitable for modern literary and scientific requirements. It is, of course, obvious that the prophecies of Isaiah and the differential equations of the problem of three bodies are somewhat remote from one another. This, however, is a question which has already been solved. Modern Hebrew, while not differing violently from the Hebrew of the Prophets or the Psalms, has nevertheless acquired a flexibility and a resourcefulness that render it perfectly suitable for scientific expression. Many Hebrew books on scientific subjects have appeared in every one of the last ten centuries, and during the present generation Hebrew books and papers on many branches of science have demonstrated how practicable it is to use Hebrew in scientific work In the secondary schools of Jerusalem, Jaffa, and Haifa, Hebrew has been used for many years, and the same applies to the Technical Institute in Haifa During the opening ceremonies on April 1, 2, and 3, a number of lectures were delivered by Jewish men of science One of these lectures on "The Meaning of Causality in Science" and another on "The Principles of Dynamics from Aristotle to Einstein" were delivered in Hebrew, while at a gathering of teachers of mathematics in Tel-Aviv, a lecture was delivered in Hebrew giving an account of a recent piece of research on the numerical solution of algebraic equations. In all cases it was felt that the use of Hebrew in no way diminished the interest and intelligibility of the lectures.

There is, however, another aspect of this language question. Is it an advantage to introduce into scientific literature yet another language? The scientific worker is already hampered by the fact that he has to read scientific papers in many different languages. This question is no doubt one of considerable importance. But it applies equally to the scientific life of Japan and India, of Russia, Poland, Rumania, Holland, and Scandinavia. The difficulty will be overcome in a similar manner. Scientific papers from Jerusalem will appear in one of the well-known languages of science, like English, French, and German. If these papers will also appear concurrently in Hebrew, this will be no concern of the non-Jewish scientific reader. The "Scripta," or publications of the Hebrew University of Jerusalem, of which a mathematical and physical volume appeared a year or so ago, are an example of this. For internal Jewish purposes it is necessary to use Hebrew on all occasions, and for scientific purposes the Hebrew will not be an obstacle.

It is not necessary to give in the columns of NATURE an account of the ceremonies that accompanied the opening of the University; the daily press has given more or less adequate accounts of these events. But a word must be said here about the remarkable position of the University. From the top of Mount Scopus there is an unparalleled view of Jerusalem—the old Jerusalem with the Temple area, the Tower of David, and other innumerable sites of historic significance, as well as the new Jerusalem which is growing up outside the walls, and which is indicative of the new life throbbing in Palestine To the east, 4000 feet below, one sees the Dead Sea and the Jordan running into it, with the mountains of Moab and Gilead in the background. These glimpses of sites hallowed by events of traditional value to so large a proportion of civilised humanity cannot fail to serve as an inspiration to teacher and student, to scholar and researcher. The plans for the complete University, prepared by Prof. Patrick Geddes, give promise of magnificent structures in harmonious keeping with the natural contours of the landscape, and with the historical contours associated with Jerusalem.

S. B.

Current Topics and Events.

THE Huxley Centenary Supplement published with this week's issue of NATURE will, we hope, be judged as modestly worthy of a memorable event. It would have been easy to extend this appreciative survey of Huxley's scientific work and intellectual influence, and we feel that many aspects of these are left unnoticed. The articles which we are privileged to publish are sufficient, however, to show the versatility of his genius and the stimulus which his life afforded to all who came in contact with him, or listened to his message to the modern world. We are fortunate in being able to publish the substance of the Huxley Memorial Lecture delivered by Prof. E. B Poulton on May 4 at the Royal College of Science, South Kensington. The lecture originated with the Old Students Association of the College, the president of which, Mr. Herbert Wright, was in the chair, and Sir Charles Sherrington, president of the Royal Society, proposed a cordial vote of thanks to Prof. Poulton for his interesting address. Sir Ray Lankester urges, in his contribution to our Supplement, that the present generation of scientific workers should turn to Huxley's life and essays for inspiration and guidance. No better advice could be given in these days of minute specialisation and the need for the application of scientific methods to problems of national well-being. The following list of works on Huxley, or by him, may, therefore, be of service: "Thomas H. Huxley," by J. Ainsworth Davis (English Men of

Science Series: Dent); "Huxley," by Gerald Leighton (The People's Books: Nelson); "Thomas Henry Huxley: a Character Sketch," by Leonard Huxley (Life-stories of Famous Men Series: Watts), "Thomas Henry Huxley," by Edward Clodd (Modern English Writers Series. Blackwood); "Huxley: a Sketch," by P. Chalmers Mitchell (Putnam's); "Huxley Memorial Lectures to the University of Birmingham," with an Introduction by Sir Oliver Lodge (Cornish); Sketches of Thomas Henry Huxley, in "Problems and Persons," by Wilfrid Ward (Longmans); "Life and Letters of Thomas Henry Huxley," by Leonard Huxley (Vols. 10, 11 and 12 of the Life and Works of Huxley, Eversley Series: Macmillan); "Huxley and Education," by H F Osborn (Scribner's); "Impressions of Great Naturalists: Reminiscences of Darwin, Huxley, Balfour, Cope and Others," by H. F Osborn (Scribner's).

THE agitation against the teaching of Darwinism in the United States, and against the use of text-books which express approval of evolution, has led to the appointment by the Board of Education of California of a committee of the nine Presidents of the State universities and leading colleges. The Board has referred to this committee a series of text-books used in the State with the request that it should report whether their presentation of evolution is such "as to discredit the Bible and to develop in the minds of high school students an attitude of irreverence and atheism." The committee has issued a list of twelve text-books in which, it says, there are no statements derogatory to the Bible, and evolution is presented as a theory—not as an established fact, and in which the treatment is such as "to show due respect and consideration for the fundamental principles of religion, as presented in the Bible" The committee quotes with approval from one of the text-books under judgment as among "Things that Evolution does *Not* Teach . . . 'That man is descended from a monkey.'" Darwin's statement on this question is emphatic. He declared ("Descent of Man," 2nd edit., 1892, p 165): The Simiadæ divided into "the New World and Old World monkeys; and from the latter, at a remote period, Man, the wonder and glory of the Universe, proceeded." It is significant of the strength of the anti-evolutionary movement in the United States that this committee, the chairman of which is president of the University of California, should endeavour to appease public opinion by its approval of such a misleading assertion, which suggests that the members of the committee are themselves in favour of teaching only a diluted Darwinism.

IN the issue for April of the Dutch monthly scientific journal *De Natuur*, H. R. Hoogenraad takes advantage of the centenary of Huxley's birth to write a concise and interesting account of his life and work, accompanied by an admirable portrait. In the introduction he refers to the alternating periods of stagnation and progress in the history of the natural sciences, periods of rapid development being observed at the end of the seventeenth and the latter half of the nineteenth century; in the former period the empirical collection of facts, in the latter generalisations and formulation of general laws, characterised the progress of science In the foreground of these generalisations stood the principle of evolution, of which Huxley was one of the foremost champions The author describes the chief stages in Huxley's career, and gives a summary of the valuable contributions to zoology which marked each of them. He shows how, from 1860 onwards, he became Darwin's chief agent in championing the doctrine of evolution Huxley's work as a teacher and lecturer is dealt with, and stress is laid on the efforts he made to bring his scientific ideas into the practical politics of the world: "Just as his life stood at the service of science, so did his science stand at the service of life" His whole life was devoted to the fight for the freedom of the human mind. Finally, the author speaks of Huxley's noble character, and of his high standard of life.

A SELECTED portion of the books which originally formed part of the collection presented to the Royal Society in 1667 by Henry Howard (afterwards sixth Duke of Norfolk), and known as the Arundel Library, came up for sale at the hands of Messrs Sotheby and Co on May 4. Some of the books reached high figures, notably two Chaucers, which sold respectively for 660*l*. and 560*l* A Cicero brought 1000*l*. Of the books which were not Arundelian, the chief contest was for Richard Baxter's "Call to the Unconverted," translated into the Massachusetts Indian language and printed at Cambridge (Mass) in 1664, the only copy known As mentioned in NATURE of April 4, this work was a gift made to the Royal Society in 1669 by John Winthrop, Governor of Connecticut, an original fellow of the Society, and it was sent over by him. It brought the exceptional sum of 6800*l*., Dr. Rosenbach being the buyer We understand that the fact of the book being actually the gift of Winthrop, which, of course, greatly enhanced its value in the eyes of American collectors, was discovered more than a year ago by Mr T E James, of the Royal Society's staff No reference, however, was made to this in Messrs Sotheby's catalogue, nor was it known, we believe, until it was recorded in NATURE, as stated above The total sum realised by the sale was 14,749*l*

THE gift of 13,000*l* from the trustees of the Captain Scott Memorial Fund to the University of Cambridge, to be applied to polar research, reminds us of the generosity of the nation in response to the appeal of the dying leader for assistance for the relatives of the men who died with him. It was from the surplus of the Mansion House Fund of 1913 that a portion was set aside "to aid polar research," and it is the balance not expended by the trustees themselves in that cause which is now handed over to an organisation at Cambridge whose duty it is to foster polar research. The phrase "polar research" should no doubt connote the actual geographical exploration of those regions as well as the study of its special problems, but the amount of the fund will obviously not

permit of monetary help to expeditions about to start, and the Polar Research Institute has to seek other ways in which to perform its function Some of these have already been begun, and the committee in charge of the Institute will no doubt find others which will be within the scope of its income But its real success will depend to a large extent on the section of the public which is interested in such matters, for it is upon those who possess records or equipment of past expeditions that one of its chief activities will depend, that is, as a centre for the collection of data and experience gathered at the cost of much labour and hardship in the past, to be used as a reference for the future

IN theory every new discovery by an expedition to the polar regions should be published to the world, if only as a return for the interest and assistance of the public, to which most expeditions owe their inception In practice this is usually quite out of the question, both on the score of expense and because it is not easy to say which results are new or important The effect has been that not only have the observations been dispersed and lost, but also that the work is continually being done over again Worse still, not a few of the disasters which have occurred are traceable to inadequate knowledge of conditions or equipment quite familiar to former travellers but never made available to their successors If the Institute, through its collection of records and literature, in print or manuscript, can help to avoid such waste of energy it will have done something worthy of its name as a memorial to one of the greatest of polar explorers There are other activities for the Institute already planned, such as the provision of rooms in which to " work up " results, the establishment of a museum of polar equipment, the loan of instruments to expeditions and possibly some small assistance in the publication of results, all of which will doubtless be developed according to demand and opportunity Inquiries should be directed to the Director, Scott Polar Research Institute, Sedgwick Museum, Cambridge, who is naturally anxious to make what information he already has collected available to those interested, and also to accept the care of any records or equipment of past expeditions which can be entrusted to the Institute.

PROF H A LORENTZ, of Haarlem, delivered the fifteenth annual May Lecture before the Institute of Metals in London on May 6 After some introductory remarks on atomic structure, Prof Lorentz discussed the mean velocity of the electrons when there was an electric current, and showed how Ohm's law could be understood without going into the details of the electronic motions. On the same general grounds an explanation was given of Tolman and Stewart's experiments, by which it was experimentally proved that an electric current in a metal consists in a motion of negative electrons He then discussed Drude's theory of conductivity for electricity and for heat, insisting on the manner in which the number of free electrons is limited by the value of the specific heat The remaining part of the lecture was devoted to the phenomenon of supra-conductivity discovered by Kamerlingh Onnes, and particularly to one of his later experiments, made with a suspended thin spherical shell of lead, in which a system of persisting parallel circular currents had been set up. This shell was placed in an external magnetic field the direction of which did not coincide with the axis of the current system In these circumstances, if the electrons were absolutely free, the axis of the current system ought to have a precessional motion about the line of force passing through the centre No trace of such a precession was observed The conclusion was, therefore, that even in a supra-conductive metal, the electrons are not wholly free in their motion It seems that definite paths are prescribed for them, along which they can move without encountering a resistance, but which they cannot freely leave sideways

SIR ROBERT HADFIELD, presiding over the Royal Microscopical Society's conference at Sheffield on April 21, during the presentation of papers on metallurgy and allied subjects, welcomed the important visit of the Society to Sheffield, and at the same time, as a fellow of the Society, thanked Sheffield for its hearty reception When a visit to Sheffield was mentioned, his thoughts turned to the memory of great metallurgists, many of whom were Sheffield men, and particularly to that of Dr H. C Sorby, sometime president of the Royal Microscopical Society—a memory Sheffield always delighted to honour It was Sorby who inaugurated metallography, not, as often stated, Martens, who began the work fifteen years later As some of the papers dealt with the question of high magnification, it was interesting to consider what was meant by high magnification work. Very fine structures exist in carbon and alloy steels, particularly when hardened. Magnifications of 15,000, though useful, do not, however, reveal much. To indicate what a magnification of even 8000 diameters means, it may be mentioned that the diameter of the actual field in a 3¼ in circle photograph is only 0 00041 in If the photograph were magnified to the same extent, it would yield a circle with an area of roughly 85 acres. With the magnification of 15,500 recently obtained by Mr R G. Guthrie, it would be increased approximately to 318 acres When Sorby's magnifications of nine diameters, which he used in his work on blister steel, are compared with a magnification of 15,000, it can be seen what advance has been made The late Prof Howe once said that present ideas on the nature of alloys were due to microscopy. A magnification of 2000 allows problems to be solved which are completely baffling at a magnification of 200. If, however, high magnifications are to be useful to the metallurgist, resolution must also be increased. The good wishes of the meeting were sent, on Sir Robert Hadfield's suggestion, to the veteran metallurgist, Prof. J. O. Arnold, who is suffering from bad health, assuring him that his past services to metallurgy are not forgotten.

DR. CHARLES CHREE, who has been Superintendent of the Kew Observatory for the past thirty-two years,

has retired and is being succeeded by Mr. F. J W. Whipple, head of the British Rainfall Organisation, Meteorological Office Dr Chree has devoted many years to the study of the phenomena of terrestrial magnetism, investigating in particular the diurnal variations which occur This has led to the discovery of an " acyclic change " ; from the averages of quiet days, the mean value of the magnetic force is not the same at the end as it was at the beginning of the 24-hour period, showing a difference which is always in the same direction Dr Chree is probably best known for his work on the relationship between terrestrial magnetism, atmospheric electricity and solar phenomena, to which recent volumes of NATURE bear full testimony During the period of Dr Chree's superintendentship, Kew has become pre-eminent among the magnetic observatories of the world

ON April 25 the Marconi International Marine Communication Company celebrated its twenty-fifth anniversary The object of the Company was to develop the use of radio-telegraphy for maritime purposes, and it may well be proud of its record. Within a few months of its formation, it had fitted radio apparatus in twenty-six warships and at six coast stations for the British Admiralty Its main business, however, is in connexion with the Mercantile Marine It has installed Marconi apparatus in more than 6000 British merchant ships Apart from its inestimable value during the War, more than 5000 lives and much valuable property have been saved during times of peace The Company has trained more than 10,000 radio operators, more than half of whom were on service during the War A news service to ships was inaugurated from the Poldhu Station in August 1903, and from this the present efficient service of ocean newspapers has developed. In 1912 radio direction-finding was first used, and more than 200 British vessels now carry Marconi direction-finders, elaborate high-speed apparatus is used on board the great liners, but small radio sets are used and are found of great value by trawlers, fish-carriers, and tugs

IN a paper read before the Royal Geographical Society on April 20, Dr A Vening Meinesz described his method of determination of gravity at sea in a submarine (NATURE, May 3, 1924, p 641, and April 11, 1925, p 550), and gave a brief survey of the problems in the investigation of which such oceanic measures of gravity should be of special importance The first and chief problem of geodesy is the determination of the figure of the earth, in which gravimetric surveys valuably supplement the data given by triangulation. Helmert's, the most recent and comprehensive discussion of the gravity data, led to the result that the equator differs perceptibly from the circular form, a conclusion difficult to reconcile with the theory of isostasy It is based on land observations of gravity, so that large areas of the earth's surface are unrepresented Oceanic observations should go far to confirm or disprove Helmert's result, particularly as the sea data appear to be more regular than land measures of gravity, except near the ocean borders. The second series of problems on which sea measures have an important bearing are those relating to the earth's crust, the stresses to which it is subject, the extent to which it can bear these stresses, and the speed with which it yields to them There is already some evidence that the principle of isostatic equilibrium is valid for the oceans as well as for the land, but there is as yet no detailed oceanic survey which can indicate what are the deviations from this state The oceanic data offer two advantages over land observations for this purpose they will probably be more regular, so that the presence or absence of distinct contraventions of isostasy should be more clearly determined, and since under the oceans there is no erosion and very little sedimentation, two complications which affect the discussion of land gravity data are removed Finally, Dr Meinesz pointed out the interest attaching to gravimetric surveys above the edge of the continental shelves

THE annual meeting of the Royal Society of Canada will be held in Ottawa on May 19-21 In Section V (Biological Sciences) the presidential address will be delivered by Prof Andrew Hunter of the University of Toronto, his subject being " Proteolysis and the Structure of Proteins " The programme includes fifty-eight titles grouped under three headings. zoological; medical, physiological, and biochemical; botanical

THE Scientific Club of Winnipeg has awarded its Research Prize of 300 dollars to Miss Mollie Weinberg for her biophysical investigations in acoustics and on gustatory sensory reflexes, which were carried out in the Department of Physics, University of Manitoba, under the direction of Prof Frank Allen.

IT is stated by the New York correspondent of the *Times* that Mr. Orville Wright intends to present to the Science Museum, South Kensington, the first power-driven aeroplane flown by him and his brother Wilbur The aeroplane has been taken to pieces and packed in crates ready for shipment from the Wright Laboratory at Dayton, Ohio

PROF ELLIOT SMITH will deliver a lecture on " The Taungs Skull—Missing Links " at University College, London, on Friday, May 22, at 5 30 P M The lecture will be illustrated by casts and lantern slides of various " missing links " The proceeds from the sale of tickets will be devoted to the St. Christopher's Working Boys' Club, 39 Fitzroy Square, W 1, which is largely maintained and organised by the students and staff of University College Particulars of the lecture can be obtained by sending a stamped addressed envelope to Miss Husbands, University College, London (Gower Street, W C 1).

THE managers of the Royal Institution, in association with the Chemical Society, the Society of Chemical Industry, and the Association of British Chemical Manufacturers, will celebrate the discovery of benzene by Faraday, at the Royal Institution, on June 16, the day on which, one hundred years ago, his communication was made to the Royal Society. The

Duke of Northumberland, president of the Royal Institution, will take the chair After his introductory speech, probably three short addresses will be given by English and foreign delegates, commemorative of Faraday's discovery and its consequences Delegates from at home and abroad will then be received and their addresses presented In the evening a banquet will be held in Goldsmiths' Hall On the previous Friday evening, a commemorative lecture on Faraday as a chemist will be given at the Royal Institution by Sir William Pope

THE Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1924-25 A Telford gold medal to Mr. Donald Paterson (Johore Bahru), a Watt gold medal to Dr. E H Salmon (London), a George Stephenson gold medal to Mr L H Savile (London); Telford premiums to Mr G Mitchell (Aberdeen), Dr. T E Stanton (Teddington), and Mr. F E Wentworth-Shields (Southampton), a Crampton prize to Prof A H Gibson (Manchester), and a Manby premium to Mr P W Robson (Lincoln)

MESSRS. R. FRIEDLANDER UND SOHN, Berlin N.W.6, Karlstrasse 11, issue a monthly bibliography of science entitled "Naturæ Novitates." The list covers much the same ground as that of the list of "Recent Scientific and Technical Books" appearing in NATURE in the last issue of every month, with the addition of the titles of some important papers appearing separately or in periodicals, but no publishers' names are given "Naturæ Novitates" is now in its forty-seventh year

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: a well-qualified graduate to take day and evening classes in mathematics and to assist in the teaching of physics at the Municipal College, Bournemouth—The Director of Education, Town Hall, Bournemouth (May 30); two student probationers at the Marine Biological Laboratory, Plymouth—The Director (May 30); a technical assistant and a junior technical assistant at the Royal Aircraft Establishment, South Farnborough, Hants—The Superintendent; a principal for the Islamia College, Lahore—The Honorary Secretary, Islamia College Committee, Lahore.

Our Astronomical Column.

THE SHOWER OF APRIL METEORS.—Mr. W. F. Denning writes "The display of Lyrids connected with Thatcher's Comet of 1861 returned this year at the usual date, but the meteors were not very numerous

"At Bristol on April 21 the rate of apparition of Lyrids, during the two hours following 23^h G M T, was found to be about ten per hour This relates to one observer watching a good sky uninterruptedly The radiant point was at 272° +34°

"Miss A Grace Cook of Stowmarket observed on April 20, between 21^h 5^m and 23^h 35^m G M T, and saw only two Lyrids On April 21, between 20^h 20^m and 24^h, twenty-nine meteors were seen, including nineteen Lyrids, and tolerably bright ones at 21^h 22^m, 21^h 42^m, and 22^h 38^m G M T At 23^h 12^m a fireball was seen of about twice the brilliancy of Venus

"On April 23, during a watch of two hours, very few meteors were seen in a splendid sky At 20^h 59^m there was a fireball directed from Virgo

"Mr A King of Ashby, Lincolnshire, watched the sky on three nights and found the radiant point of the Lyrids as follows.

April 20	269°·5	+33°	7 meteors
,, 21	271	+33 5	17 ,,
,, 23	273	+33	6 ,,

He observed a brilliant fireball on April 20, 23^h 38^m G M T, with a flight from 230° - 8° to 231° - 13° in 0·7 second"

CALENDAR REFORM.—Mr R. M Deeley, in a letter to the Editor, repeats the suggestion, frequently made before, that one day in each year, and two in leap year, should stand outside the week, so as to make the incidence of week days the same every year. This suggestion was approved by the Committee on Calendar Reform at the Rome Meeting of the Astronomical Union in 1922 But the Union as a whole refused to endorse it There is, in fact, a widespread dislike to alter the regular sequence of the week days, which has been uninterrupted for something like 3000 years.

There is one suggestion which gives a fixed calendar without tampering with the week. It is to make the year exactly 52 weeks, and every fifth year 53 weeks By occasional modifications of the five-year cycle (similar to the Gregorian adjustment) the mean length of the year could be kept right But the difficulty of adjusting salaries and wages to years of such varying lengths, coupled with the large oscillation in the dates of the equinoxes and solstices, would be grave difficulties, and would almost certainly prevent the adoption of the scheme

THE OLDEST TRANSIT INSTRUMENT.—In an interesting article on "The Oriental Ancestry of the Telescope" (*Scribner's Magazine*, April), Dr. G. E. Hale, director of the Mount Wilson Observatory, describes the discovery of a transit instrument made by King Tutenkhamen Prof Breasted, of the Oriental Institute of the University of Chicago, who was working in Egypt in the spring of 1923 at the tomb of Tutenkhamen, proceeded afterwards to London, where he found the instrument at the shop of a well-known dealer in antiquities. It is the oldest transit instrument that has yet been found "It is a rectangular strip of ebony wood a little over ten and one-half inches long (perhaps intended for half a cubit), one and one-sixteenth inches wide, thickness just one-half inch. Along each edge, extending entirely from end to end, is an inscription stating that the object was made with his own hands, by King Tutenkhamen, as a restoration of a monument of his father (meaning his ancestor), Thutmose IV. . . . At one end of the ebony strip is a rectangular mortise hole a little over half an inch long, about three-sixteenths inch wide, and a scant one-fourth inch deep. It is clear that this mortise hole contained a tenon holding in place a little block mounted on the end of the ebony strip. To the block was attached a plummet, and a vertical line cut in the edge of the ebony strip exactly opposite the middle of the mortise hole marks the place where the plummet cord descended." In using the instrument the observer looked through the hole, held close to the eye, and noted the moment when certain stars passed across the plumb-line suspended in the meridian.

Research Items.

A STATUE-MENHIR FROM TRAMIN, SOUTH TYROL.—Dr. O. Menghin of Vienna describes in *Man* for April a sculptured stone, now in the Ferdinandeum Museum at Innsbruck, which is from the Tyrol, but unique in that region. It is of sandstone, 181·5 cm high, 57·6 cm broad, and 25·77 cm thick, and is shaped like a column, with square section and triangular top. It is worked superficially to represent a human figure—an armed man, but the face is not indicated. It recalls the statue-menhirs of southern France and upper Italy. The Tyrol example is linked to the Italian group by the occurrence on each of daggers with triangular blades, narrow handles, and circular pommels. The daggers which occur rarely on the French statues are of different type. Similarity to a dagger in the wall painting of Peña-Tu in Spain, usually attributed to the Bronze Age, and the age assigned to the Fivizzano monuments of Italy, suggests a similar date for the Tyrolean menhir. Typologically it is intermediate between the French and Italian types, and is therefore to be connected with the West European culture cycle. It is suggested further that the statue-menhir may represent not a god or goddess of death, but may be the image of persons buried originally at the foot of the monument.

SCOTTISH ANTHROPOMETRY.—Prof. R. W. Reid and Mr. J. H. Mulligan have published in the Journal of the Royal Anthropological Institute, vol. 54, pt. 2, a study of the stature, head-length, and head-breadth of eight hundred and forty-seven natives of the north-east of Scotland. The material was collected in the Anthropometric Laboratory of the University of Aberdeen. While stature appeared to be a determining factor in head-length, head-breadth depends on the conformation of the skull itself. This was confirmed by a calculation of the cephalic index, the stature tending to vary inversely as the cephalic index. A comparison between natives of the north-east of Scotland and inhabitants of Norway and Sweden yielded some interesting results. Broadly speaking, the Scottish students resembled the Scandinavians in that they were tall and meso-cephalic. They were particularly like the Swedes as regards the shape of the head. They were like the Norwegians in shape of face and nose, on the average both features being narrow. No comparison with Swedes was possible from deficiency of observations of these features. The colour of the hair was intermediate between Swedes and Norwegians. The eyes were darker. The Scottish students showed a higher percentage of the Nordic type when pigmentation was disregarded, but, subject to qualification due to certain defects in the evidence, when pigmentation was also taken into account, the percentage of this type in the Scottish material fell below that of Sweden. In all three groups the percentages of Mediterranean and Alpine types were negligible.

MARINE BIOLOGY AT PLYMOUTH.—The March issue of the Journal of the Marine Biological Association contains papers of wide general interest, both in hydrography and general marine biology. Very notable are three contributions. Mr. W. de Morgan describes (with excellent figures) the marine ciliates living in the tanks at the Plymouth laboratory (there is one new species). This is a paper of outstanding merit and usefulness to zoologists. Dr. Marie Lebour gives a most interesting account of young angler-fish larvæ and their enemies, as studied in a plunger jar in the laboratory; the figures are quaint and very instructive, and should be used by all teachers. Mr. O. D. Hunt gives results of investigations into the food of bottom-living animals of the Plymouth region. This paper contains an account of special observations, but it also includes a very useful general discussion of modes of nutrition among demersal animals and of the rôle of organic detritus in the feeding of bottom organisms, and it has some very beautiful and interesting photographs.

ANTS OF THE ADRIATIC REGION.—Since the year 1908 Dr. Giuseppe Müller has been engaged, at first in conjunction with Dr. Carlo Wolf, who died as a result of wounds sustained in the War, and later with the collaboration of Bruno Finzi, in the classification of the ants found in Julian Venetia and Dalmatia. The results of their investigations, which correct many of the observations made or recorded by earlier authors, are now published in volume 28 of the Bulletin of the Adriatic Society of Natural Sciences (Trieste). The catalogue comprises 89 different species and extends to 170 pages, the characteristics of each species, and its habitat, etc., being described in detail. Alphabetical indexes, both of the sub-families and genera, and of the species, are appended, as also is an accessory table by means of which any individual specimen may be accurately placed.

GENETICS AND WOOL PRODUCTION.—Prof. A. F. Barker discusses this subject in an address to the Pan-Pacific Science Congress, Sydney, 1923, published in the Journal of the Textile Institute and now re-issued. He reviews the history of genetics and points out its importance to the practical sheep-breeder. Several interesting points in the genetics of sheep are brought out. For example, the offspring of a cross between a Lincoln ram and a Merino ewe are said to be gregarious, while those from the reciprocal cross are non-gregarious. This, if confirmed, would be a fact of much interest. In a century of breeding the Merino in Australia, the wool-production has increased from about 4 lb. to 8 lb. or 10 lb. per fleece. It is probable that the wild sheep originally shed its coat yearly, and that man has selected strains under domestication in which this power was lost.

INFLUENCE OF MAGNETIC FIELD ON BLOOD-VESSELS.—Recent experiments by the Russian physiologist N. P. Kravkov have shown that an isolated ear of a rabbit, kept in the Ringer-Lock's solution, responds by rhythmical changes in the diameter of blood-vessels to each opening and closing of a circuit connected with an electro-magnet creating a magnetic field near the ear. According to P. P. Lazarev (*Comptes rendus*, Russian Academy of Sciences, 1923) this may be explained on the basis of the ionic theory of excitation. Each opening or closing of the circuit results in an electro-magnetic impulse which spreads in space with the same velocity as light. This impulse may affect the nervous centres in the walls of blood-vessels which influence contraction of the latter, so that the whole process may be explained by the electro-magnetic impulse giving rise to a certain chemical reaction of short duration in the nervous centres, resulting in a pulsation of the vessels. This explanation requires experimental tests, but it is important that further studies of the interesting phenomena discovered by Kravkov should be made along some definite lines arising from the above theory.

VARIATION IN COCONUTS.—Volume 13, No. 2, of the *Malayan Agricultural Journal* is devoted to a study of variation in coconuts by Mr. H. W. Jack.

Not only do marked variations occur in the colour, size, and shape of the fruits produced on particular trees, but also in the yield Other variations are known to occur in root formation, in the thickness and oil content of the "meat," the rate of germination of seed-nuts, and other features, many of which are economically important Growing side by side under similar soil conditions, trees retain their individual characters The necessity for greater care in selection is pointed out, and also the desirability of planting seed-nuts only from trees having favourable characters Frequency curves show the various ranges of variation The progeny row method is adopted, and the fruiting capacities of these rows will form the basis for more accurate future investigations

TIDAL OSCILLATIONS IN THE LAVA PIT OF KILAUEA.—Mr Ernest W. Brown has recently considered the existence of tidal oscillations in Halemaumau, the lava pit of Kilauea (*Amer. Journ Sci*, vol 9, 1925, pp 95-112) During an interval of 28 days in 1919, an almost continuous series of measurements was made of the vertical distance below a station on the outer edge of the pit of two points, one on the lava crust near the centre of the pit, the other of the liquid lava in the lake. While oscillations with other periods may exist, the paper is confined to those with tidal periods, namely, 24 h 50 m. and 12 h 25 m Two analyses of the observations were made, and the author concludes, as regards the variations in the height of the crust-lava, that "there is some evidence of tides, with the periods of the lunar day and lunar half-day, with double amplitudes of an inch or so. . . The variations of height of the liquid lava are too irregular to show small tidal effects"

LONDON'S ATMOSPHERE.—The issue of the Journal of the Royal Society of Arts for March 27 contains a lecture by Dr. J. S. Owens on the conditions of the atmosphere over London. While over the North Sea outside Spurn Head there are 140 dust particles per c c of air, over London there are on an ordinary winter day 4000 or 5000 and during a fog 100,000 per c c. During a working day, as shown by the curve published in NATURE of December 15, 1923, the amount of suspended matter in the air over London increases from 6 A M to a little after noon and then decreases to a minimum at 6 A.M It is least on Saturdays and greatest on Wednesdays The tarry nature of the suspended matter shows that it is due mainly to domestic smoke, as factory smoke is almost free from tar Dr Owen estimates that the domestic fire is responsible for about 70 per cent. of the London smoke Increase of speed of the wind decreases the amount of suspended matter per c c., and rain brings down with it a considerable quantity of the soluble matter Although there has been a reduction of about 40 per cent in the amount of suspended matter in the last eight years, there is still ample scope for improvement, especially in respect of domestic fires.

IS ELECTRICITY ATOMIC?—In the April issue of the *Philosophical Magazine*, Prof. Ehrenhaft, of the University of Vienna, summarises his investigations of the past sixteen years, which have all led to the conclusion that the minute particles used in measuring the alleged atomic charge of electricity frequently possess charges which are fractions of that atom. An editorial note which accompanies the paper explains that owing to the interruption of international communications during the War, these attacks on the orthodox position as to the atom of electricity may have been to some extent ignored. NATURE, however, directed attention to them on August 11, 1910, on January 19, 1911, and on February 8, 1912 In his most recent work Prof. Ehrenhaft uses particles of radioactive substances of radii less than 3×10^{-5} cm. and finds that their individual speeds in the electric field in which they are observed vary so nearly continuously as to imply that their charges vary with time by amounts which are much smaller than the orthodox atom of electricity of $4{\cdot}77 \times 10^{-10}$ electrostatic units

PYREX GLASS.—An article on English "Pyrex" glassware, by G E Stephenson, appears in *Chemistry and Industry* for March 20 Pyrex glass is a borosilicate glass of high silica content first produced by the Corning Glass Works, U.S A, as a substitute for Jena and other German glass, supplies of which were stopped by the War The coefficient of expansion of the glass is 34×10^{-7}, below the limit proposed by the Reichanstalt for first-class glasses for flame protection purposes This enables Pyrex ware to be made thicker than usual for glass articles, with consequent increase in mechanical strength English manufacture of Pyrex ware was commenced in June 1923 by the Wear Flint Glass Works, the manufactured articles include teapots, cooking utensils, and such like, besides the more conventional test-tubes, beakers, and flasks An outline is given of the general methods used in the manufacturing processes It is considered that the demand for Pyrex laboratory glassware will greatly increase.

CONVERSION OF STEAMSHIPS TO MOTOR-SHIPS.—A paper on this subject, read by Eng. Lt.-Comdr. L. J. Le Mesurier before the North-east Coast Institution of Engineers and Shipbuilders on March 27, gives an interesting comparison of the performances of the *Buitang* before and after conversion. This vessel was built in 1916 for the Nederland Steamship Company, and is 417 ft. 8 in. long, with a displacement of 14,000 tons. The original steam plant consisted of triple expansion engines of 3600 I.H.P. at 85 rev. per min The main engine of the new propelling machinery is a Sulzer two-stroke engine with direct driven scavenge pump, and has a normal output of 3600 B H P. at 90 rev. per min. During the official shop trials this engine developed as much as 4390 B H P. at 96 rev per min. during an overload trial. The fuel consumption at normal load was 0·410 lb. per B H.P. per hour, and the mechanical efficiency was 78 3 per cent The fuel consumption for all purposes with the original machinery worked out at an average of 1·5 lb. of coal, or 1 1 lb. of oil fuel per I.H.P. per hour; these correspond to 58 tons of coal or 41 tons of oil fuel per day at sea. With the new plant the total consumption per day at sea will be 14·7 tons of fuel. The total annual cost of fuel, including both sea and port consumptions, is 27,780*l*. before conversion and 14,230*l*. after conversion, showing a total annual saving of 13,550*l*. Before conversion the ship could remain at sea 43 days, and after conversion 164 days. Thus, taking in 2000 tons of fuel at Batavia, Java, or other ports, will enable the vessel to complete the round trip to Holland and back, and will permit of 1000 tons of extra cargo on the outward voyage. Staff savings will amount to 1440*l*. per annum. The actual cost of the conversion will probably be 70,000*l*., and the net saving is estimated at 14,500*l*. per annum—a return of more than 20 per cent. on the capital outlay. Figures are also given for the converted vessel *Wieringin* during a voyage from South America, showing that the speed has been increased by about 20 per cent., despite bad weather, and the cargo carried was about 10 per cent. greater.

Echo Sounding.

THE extent of the interest which has been excited in foreign navies by the proved rapidity and accuracy of soundings obtained by the method of echo depth sounding is indicated by contributions to the latest number of the *Hydrographic Review*[1] "Sonic" echo methods, in which the compressional waves sent out from the underwater transmitter are of audible frequencies, are dealt with in part of an article which contains a summary of the results obtained by previous writers in this field, and in an article by Dr H C Hayes, Research Physicist of the U S Navy, in which is set forth the theory of three different methods of obtaining depths by sonic echoes These methods have been described elsewhere and the principles are now well known Apart from what is known as the "angle method," which is most appropriate to shallow depths, all sonic echo methods reduce to artifices for indicating in a simple and trustworthy manner the interval of time which elapses between making an underwater signal and the return of the echo from the bottom, and methods of avoiding disturbances in the receiving apparatus due to the original signal A simple device, produced by the Scientific Research Department of the British Admiralty, achieves these objects and has already been described in these columns[2]

In principle the device is similar to, but differs in an important practical detail from, the Fessenden apparatus described in the *Hydrographic Review* It is noted that no reference is made in the summary of recent work on depth sounding to the British Admiralty type of sonic sounder or to the simple "Fathometer" of the Submarine Signal Corporation of Boston, Mass, which also resembles the Admiralty apparatus The writer in the *Hydrographic Review* is in error when he states (on p. 66) that the sonic method can be used only for "rather considerable depths, *e g* 50 fms" According to the above-quoted article in NATURE, the British Admiralty sonic sounder has been used with success in water so shallow that the vessel was only just afloat

A range of possibilities which will be entirely new to many of those who have studied sonic echo methods is suggested in that part of the article which deals with the use of "ultra-sonic" waves in echo sounding. As the name indicates, ultra-sonic waves are compressional waves of frequency so high as to be inaudible to the human ear. The writer of this section of the report describes apparatus patented by Prof Langevin and M. Chilowsky for producing these high frequency vibrations, and gives information concerning their properties, which are of great scientific interest.

If we assume that the direction of an object which causes an echo can be estimated with as much accuracy as that of a source of sound, we might imagine that rocks and other navigational dangers could be detected by echoes of sounds produced by submarine bells or Fessenden oscillators, and that indications of their direction might be obtained by the use of hydrophones having directional properties, or by the use of some underwater receiving system like the multiple rotating trumpets used for detecting and locating aircraft at a distance by the binaural effect. Theoretically neither idea is impossible, but there are great practical difficulties to be overcome. Since the velocity of sound in sea water is much greater than in air, our underwater "trumpet" system must be about five times as large as a system of similar accuracy in air. Any one who has seen photographs of the air trumpets used in anti-aircraft work will appreciate the impossibility of fitting such a device under water in a vessel The idea of an effective underwater analogue to the air trumpet must not, however, be dismissed as absurd, for the U S Navy M-V Hydrophone described by Dr Hayes does for underwater signals what the trumpets do for sounds in air

Again, for physiological and psychological reasons, it is extremely difficult to obtain the direction of a source of sound (and hence of an echo) with a directional hydrophone unless the sound is continuous, or nearly so, and this introduces the question of effectively screening the receiver against the shocks due to the outgoing signals, in order that the listener may not be so deafened that he cannot hear the comparatively faint echo It would be very difficult, if not impossible, to devise a method of screening which would be satisfactory under these conditions, and in any case accurate direction cannot yet be obtained with a simple directional hydrophone There is a further serious objection to the use of sonic echo methods for determining the direction of objects under water Owing to the long wave-length of audible sounds, very little energy is reflected by a small object, and a floating wreck might thus easily be undetected

In spite of all the difficulties which beset those who searched for better navigational methods, an idea which originated with an Englishman, Richardson, soon after the loss of the *Titanic*, has now materialised Richardson's idea was to project a "beam" of sound from a transmitter fixed in a vessel and to receive the echoes from submerged obstructions The beauty of the "beam" idea lies in the fact that if an echo is received, then something with acoustic properties different from those of sea-water is known to lie in the direction in which the transmitter is pointing That is, the source of an acoustic beam acts the part of a searchlight projector, but under water The difficulty lay in producing a beam of sound, and for a long time the idea remained uninformed

It is useful here to return to fundamental principles and to remember that the sources of radiation with which we commonly deal are non-directional unless their size is large compared with a wave-length of the radiation emitted, or other steps are taken to concentrate the energy Mr Marconi has shown how directional wireless beams can be produced by using what are in effect transmitting surfaces of size comparable with the wave-length used Light may be concentrated into a beam by mirrors because even a very small mirror is many wave-lengths in diameter Since the wave-lengths of audible sounds are measured in feet, it is clear that it is necessary to use sound sources of high frequency in order to reduce the size of the necessary focussing arrangements to practical dimensions

It can be shown theoretically that a flat circular plate of diameter about 8·7 inches, vibrating in a direction perpendicular to its plane with a frequency of 40,000 cycles per second (corresponding to a wave-length in water of about 1½ inches), produces a beam of energy with an angle of divergence of about 10°, and containing nearly all the energy passed into the water by the vibrating plate Now it is clear that a transmitter very much larger than this is impracticable, while use of a lower frequency would reduce the sharpness of the beam. Hence, the designers of sound beam apparatus were faced with the problem of producing an oscillator having a frequency approaching 40,000 cycles per second

Prof. Langevin and M. Chilowsky discarded electrical and mechanical generators, the use of the effect

[1] *Hydrographic Review*, vol. 2, No. 1, Nov. 1924, pp. 51-121.
[2] NATURE, March 29, 1924, pp. 463-65.

of magnetostriction, condenser-transmitters, high frequency sirens, and whistles—after having tested some and having been told the results of the tests of others—and eventually decided to use the piezo-electric property of quartz,[1] discovered by the Curies in 1880. Quartz, like some other crystals, cut in a particular way with respect to the crystallographic axes, expands or contracts when an electrical potential difference is applied to certain faces of the crystal This effect is very small for practical voltages and sizes of crystal, and there is a corresponding reverse phenomenon Thus, if alternating potentials, which may be generated by an ordinary oscillating valve circuit, are applied to a crystal, corresponding mechanical vibrations will be set up in it, and thus energy may be passed into water if the crystal is submerged in the sea Similarly, the crystal will be strained by any vibrations in the water and the corresponding electrical effects may be amplified and detected by known means.

Now the energy emitted by per unit area of an oscillator of this kind depends, among other things, upon the frequency and voltage of the applied current To obtain an energy emission of only 1 watt per square cm., alternating potentials of the order of 50,000 volts would have to be applied at a frequency of 40,000 cycles per second, were it not for the fact that Prof Langevin chooses the thickness of his quartz so that it is in mechanical resonance with the power supply—that is, the thickness of the quartz is equal to one-half wave-length (in quartz) of an elastic vibration of the frequency considered. It is interesting to note the use by Cady and others of this phenomenon of electro-mechanical resonance in piezo-electric crystals in designing frequency standards for wireless and other purposes Standard oscillators so constructed are small, robust, easily portable, and little affected by normal changes in temperature

In practice, the oscillators used by Prof Langevin and M. Chilowsky are stated to have been built up of a layer of pieces of quartz cemented together with insulating compound between two sheets of steel, the whole being arranged so as to be in mechanical resonance with the frequency of the alternating supply An increased energy emission was then obtained and it was found that the required output could be obtained with only about 2500 applied volts. The oscillators are, of course, specially constructed to withstand both electrical and hydrostatic pressures without breakdown, and sectional drawings of an oscillator and its mounting are given in the article.

It is pointed out in the article under notice that the optimum frequency of transmission is determined by energy losses in the water as well as by the practical limit of size of the oscillator. Energy losses in water increase with increasing frequency, and a formula is given which shows that the amplitude of the compressional wave diminishes with distance according to an exponential law, similar to those which hold for other vibrations passing through absorbing media.

The method adopted to measure the vibrational energy in the water at the high frequencies used in supersonics is interesting. The principle is the same as that upon which the radiometer depends, namely, the relationship between radiation pressure and the energy per unit volume of the medium. The pressures exerted by the supersonic waves were measured by a torsion pendulum in a manner which recalls the use of the Rayleigh disc for obtaining information about the amplitude of air vibrations in resonators.

There appears to be an error in dealing with this question on pp. 60 and 63, in that energy is proportional to the square of the amplitude of the vibration, and the argument on p. 59 relating to the absorption of electro-magnetic and acoustic energy by sea-water is clearly fallacious Incidentally, the paper appears to have suffered some loss of clarity at the hands of the translators, especially in the theoretical portions The statement on p. 63 regarding the reduction in energy due to viscosity is worthy of further notice. The conclusion that supersonic waves, having a frequency of 40,000 cycles per second, should travel some 32,000 yards in sea-water before their energy is reduced to one-third of its initial value, taken in conjunction with the statement on p 83 that a signalling range of 4·9 nautical miles was obtained, suggests that, even with a beam of small divergence, the energy losses over such ranges depend less on viscosity than on the value of some multiplying factor depending on such quantities as the range and beam angle. The value of this factor is not discussed, but some idea of its possible magnitude may be gained from the work of Barkhausen and Lichte reported recently in the *Annalen der Physik*.

The final portion of the paper is devoted to descriptions of the methods which may be used for depth sounding or the location of wrecks, etc., by the ultra-sonic beam The same oscillator is used for reception and transmission, and can be rotated in its mounting In one method an oscillograph is used to record the time-interval between the outgoing and incoming signals In an alternative scheme a fluxmeter is used to integrate a current which flows during the echo interval, and thus a measure of time is obtained. An interesting cross-connected circuit containing two thermionic valves is used to start and stop this current without mechanical relays. It is stated that direct signals have been transmitted with the piezo-electric oscillator over 4·9 nautical miles, soundings taken down to 245 fathoms, and floating bodies located at more than 2000 yards If the object from which echoes are being received is not the sea bottom but is a floating body, the method gives information both as to its distance and its direction. The latter is as yet unobtainable by sonic methods of depth sounding. But, as direction is generally immaterial in depth sounding, it appears to be doubtful if there is here a large field of utility for what is clearly at present a complicated and expensive piece of apparatus, which would only be safe in skilled hands. Also it may perhaps be permissible to express a doubt as to the results which would be obtained if the supersonic beam were used to detect icebergs. On theoretical grounds it seems improbable that a large proportion of the beam energy would be reflected, because the constants of water and ice which determine the amount of the reflected energy are not notably different

Whatever may be the limitations of the present device, there is no doubt that, as in many other instances, simplification of design and operation will follow further research, and an aid to navigation of inestimable value will eventually be at the disposal of all who take ships to sea. By the use of the successors of this apparatus the danger of collisions at sea may be greatly reduced, and one is tempted to wonder how many out of the thousands of a future generation of travellers will give a thought to the two scientific workers who, more than forty years ago, discovered the obscure phenomenon on which this method of signalling depends, or to those who have more recently worked out its application. It is a pity that in an age of hurry we are forced to take so many things for granted. J. B.

[1] On p 75, dealing with this point, it is presumed that "Sir E. Rutherford" should be read for "Sir E Richardson."

The Microscope in Science and Industry.

A CONFERENCE of the Royal Microscopical Society was held at Sheffield, April 20-22, which was attended by many fellows of the Society and some eighty delegates from other societies Members of the Conference were received on Monday afternoon at the Town Hall by the Right Hon the Lord Mayor and Lady Mayoress and in the evening at the University by the Vice-Chancellor.

On Tuesday morning, April 21, the scientific proceedings were opened by an address from the president, Mr A Chaston Chapman, who said that he had very great pleasure in presiding over the first Conference held out of London under the auspices of the Royal Microscopical Society. It was his firm belief that the Conference could not fail to exercise a powerfully stimulating effect upon the development of that branch of pure and applied science which it was the special function of the Society to represent The Society was established in 1839 for the promotion of microscopical and biological science in general In process of time and with increasing emphasis during comparatively recent years, the microscope has become an essential instrument of research and control in a large number of industries. It is difficult to think of a single industry in which the microscope is not an instrument of almost daily use, and there are many in which it has led to discoveries of fundamental importance The Society's attentions are not, however, confined to industrial applications of the microscope The other and older activities have been in no way neglected, the ordinary meetings, as well as those of the Biological Section, are characterised by a vitality which augurs well for the Society's future and for the successful carrying out of the great task it has undertaken With the introduction of new instruments of research and the continuous development and refinement of the older ones—amongst which the microscope occupies a foremost position—the scientific investigator will find new fields of inquiry ever opening out before him Many instruments with which the scientific investigator is concerned yield indications which may be described as indirect, it is the main interest of the microscope that it reveals the actual object to the eye, and with certain qualifications necessitated by technical imperfections, and apart from metaphysical subtleties, it can be assumed that what is seen is the thing itself. The microscope would appear to be the only scientific instrument which can claim a Society for its own, and when it is remembered what it has done in the past for human knowledge and its possibilities are considered, it seems worthy of that honour. When it is realised that rulings of more than 100,000 to the inch can be resolved and that the largest molecules such as those of starch or proteins may not be beyond the power of modern ultramicroscopic perception, results may be within reach which even the rashest and most imaginative would scarcely dare to predict.

Some of the papers presented during the morning were read in title only. A joint paper on "The Development of the Use of the Microscope in Steel Works," by Sir Robert Hadfield, Mr. T. G. Elliot, and Mr. G. B. Willey was read by Sir Robert Hadfield. Modern metallography is based upon the observation under the microscope of the internal structure of metals. The paper traced the outline of the development of this application of the microscope and gave examples of its help in works-problems connected with ferrous metals. A comparison of the microstructure of metals with their chemical, physical, and mechanical properties often shows that microscopic examination affords an economical method of interpreting irregularities. A paper by Mr F F Lucas (New York) on "New Facts developed by High-power Metallography" also brought forward some interesting points The micro-structure of austenite, martensite, and troosite was described, the process of decomposition of austenite and martensite to pearlite, and cold work and regranulation was discussed. Another paper that attracted much attention was one by Mr J Ramsbottom on "Some Points in the Life Histories of Yeasts" There is apparently an alternation of generations in yeasts Endospores either germinate directly and give rise to dwarf forms or copulate in pairs to produce normal colonies It is possible that some of the numerous "species" of Torula, so troublesome particularly to medical men and brewers, are really dwarf forms of Saccharomyces The importance of this to the brewing industry is indicated by the fact that the "Hofbrau" yeast, which is of the typical "Frohberg" type in the normal form, is of the "Saaz" type in the dwarf form It is interesting to note in connexion with the modern tendency to use light of short wave-length in microscopy that the paper was illustrated by a number of ultra-violet (cadmium) light photomicrographs taken by the late Prof K Kruis

The morning's proceedings ended with the inevitable photograph of members of the Conference In the afternoon, visits to the works of Messrs Thomas Firth, Vickers, and Walker and Hall gave a new meaning to the blessed word "steel" to southern biologists. The proceedings on Tuesday were completed by a reception by the Master Cutler at the Cutlers' Hall

On Wednesday morning the majority of the papers had a "technical" bias Mr Conrad Beck advised caution in the interpretation of microscopic images Examination of a microscopic image with another microscope shows that, due to diffraction, it is a disc surrounded by a few rings of light Two points are pictured as two discs, a row of points forming a line is a row of overlapping discs or a band of perceptible thickness A structure of lines is portrayed as a series of bands more or less overlapping and confused The size of the disc-image of a point is the factor governing resolution If the band-images of two lines in the object do not overlap, they can be recognised as two elements and are said to be resolved When the bands are of a thickness equal to their distance apart, they can just be resolved, thus if a microscope has a resolution of 1/100 lines to the inch, every detail that it shows will appear to be 1/100 of an inch larger than it really is Resolution is the correct method of describing the sharpness with which a microscope will show an object The rings round the disc image may generally be disregarded, though under certain conditions they are visible, and many of the sheaths supposed to surround bacteria are really diffraction contour lines The size of the diffraction disc depends on two factors the angle of the cone of light collected by the microscope from each point of the object and the wave-length of the light that passes from the object into the object-glass. These factors determine the amount of detail that actually exists in the image—but sufficient magnifying power must be employed to render such detail visible to the eye. The limiting factor of microscopic vision is not magnifying power but aperture and wave-length. Large magnifying power without sufficient aperture is empty magnification From 1000 to 1500 diameters is as large a magnification as can be advantageously used with anything but ultra-violet light. The use of an immersion lens has the

effect of reducing the wave-length of the light and thus increases resolution. The illumination of opaque objects or dark-ground illumination utilises the whole aperture of a microscope because the object acts as a self-luminous body. With transparent objects the resolution is profoundly influenced by the illumination. The correct method of providing this with a substage condenser was discussed in its various aspects, and its relation to glare and the difficulties of delineating almost transparent structures considered

Mr H. Wrighton spoke on "Some Details in Metallurgical Microscopy" and went rather fully into the matter of illumination Dr Rogers discussed test objects for metallurgical microscopy Microscopists have had for a long time a number of test objects by which the comparative merit of a lens can be readily ascertained To metallurgists, pearlite is most commonly available. For powers of 1000 and upwards, stainless steel was suggested The final paper was by Mr W. J Rees on the microexamination of refractory materials There are three methods available The examination of thin transparent sections by transmitted light by the application of normal petrographic technique The examination of flat polished surfaces by reflected light, which is difficult to apply on account of the friability of most refractories, the comparative effects obtained by the use of etching reagents such as hydrofluoric acid, are not sufficient to distinguish many common constituents. The examination of powdered materials is especially useful in the examination of silica bricks and of fused alumina-silica refractories

Sir Robert Hadfield proposed that representations should be made to the Royal Society that the Sorby Research Fellowships should be used for the furtherance of metallurgical microscopy by research on the question of higher magnification and better resolution. The official proceedings closed with votes of thanks to the Lord Mayor, the Vice-Chancellor of the University, Sir Robert Hadfield, and the Local Committee Parties of members spent the afternoon in visits to the works of Messrs Hadfields, Cammel Laird, and Joseph Rodgers

Throughout the Conference an excellent trade exhibition of microscopical and cognate apparatus was open in the Chemistry and Physics Laboratories of the University. Of many excellent and dazzling instruments it would seem invidious to mention any particular exhibit. At the same time a number of novelties attracted a great deal of attention, and in the circumstances it was natural that these should be of particular service in metallurgical work. Messrs. Beck's exhibit included a "Radial" photomicrographic apparatus of great convenience and rigidity Messrs Chapman and Alldridge showed some of their vertical illuminators at work, Messrs J. W Ogilvy showed amongst other items a 16 mm. oil-immersion objective, and Messrs Swift a micro-goniometer.

The "Honey-Sense" of Bees.

A RECENT paper by Frisch[1] records some interesting observations on the manner in which bees notify to members of the same hive the existence of a rich source of honey. By the use of a glass-fronted observation hive and by marking the bees with various combinations of coloured spots, Frisch states that he found that a bee which had just returned from an exceptional source of supply, performed a rapid dance lasting from thirty to sixty seconds This might be repeated in one or more places in the hive, during which the performing bee necessarily came in contact with the surrounding insects, and it was observed that these latter stroked the abdomen of the dancing bee with their antennæ. Afterwards these same bees emerge from the hive and search in ever-widening circles, up to a kilometre away from the hive, for the source of honey the existence of which has been communicated to them in the manner described.

Experiments showed that in this search the bees are in part guided by the flower scent associated with their informant After collecting their honey-loads they in their turn regain the hive and exhibit the same dancing movements, thereby enlisting additional recruits for the exploitation of their find But the number of bees thus brought is more or less proportional to the honey supply as, if access to an artificial source of honey is rendered difficult, the returning bees do not dance and no addition is made to the numbers collecting from this source.

From the greater ease which Frisch experienced in training bees to scent as compared with colour, and from the fact that recruits came to scented but not to scentless flowers, he concludes that scent is more important than colour This view, whilst in agreement with that of Plateau, is at variance with the conclusions of Wery, who found that flowers which were completely enclosed in glass globes attracted bees as readily as those exposed. Frisch's views on the importance of scent and the seat of this sense in the antennæ is difficult to reconcile with Forel's experience that bees from which the antennæ had been removed visited flowers with even greater precision than unmutilated individuals In addition to the flower-scent perceived by recruits as attaching to the returning bees, Frisch adduces evidence to show that the bee possesses a scent-gland by means of which it secretes a volatile substance at the honey source, and this, together with the scent of the flower, guides the recruits to their destination

Pollen-collecting bees likewise perform a dance when returning from a rich source of pollen, but this is stated to differ in character from that performed by the honey-collectors. Here too the recruits are guided both by the pollen scent and the scent secreted by the recruiting bee. E. J. S.

[1] K.v Frisch, "Sinnesphysiologie und Sprache der Bienen." (Berlin: Julius Springer, 1924.) 1 20 gold marks.

University and Educational Intelligence.

CAMBRIDGE.—The trustees of the Captain Scott Memorial Fund have offered to hand over to the University a sum of about 13,000*l.* for the erection, endowment, and maintenance of the "Captain Scott Polar Research Institute." They suggest that 6000*l.* be set aside for the building and its upkeep, indicating that there are clear advantages in the Institute being a wing of a departmental building; presumably the Trustees have the Department of Geography in mind, and it may be hoped that this gift may stimulate into success the endeavours that have been made to secure adequate accommodation for the Department The Council is to propose a Grace gratefully accepting the proposed gift.

Lord Ullswater, chairman of the Cambridge University Commissioners, has informed the Vice-chancellor that in order to enable the Commissioners to organise a Faculty system for the University, as proposed by the recent Royal Commission, and also in order to meet some of the most pressing needs of the Library, the Government has increased the annual state grant from 60,000*l.* to 85,000*l.*

Dr J. H Jeans, Trinity College, will deliver the lecture on the Rouse Ball foundation on May 11, his subject being "Atomicity and the Quantum Theory."

Mr. C Warburton, Christ's College, has been re-appointed as demonstrator in medical entomology. Mr. G. F. C. Gordon, Trinity College, and Mr L G. P Thring, Trinity College, have been re-appointed as superintendents of the Engineering Workshops and of the Engineering Drawing Office respectively

It is proposed by the General Board of Studies that Mr. D. Keilin, Magdalene College, assistant to the Quick professor of biology, be elected a University lecturer in parasitology.

Sir Humphry Rolleston, Bart., Regius professor of physic, has been re-elected a fellow of St John's College

Dr. G. E. Moore, Trinity College, has been elected to the professorship of mental philosophy and logic

EDINBURGH.—Sir Arthur Keith, Munro lecturer in anthropology and prehistoric archæology for 1925, commenced on May 1 a series of ten lectures on the study of man's evolution as told by his fossil remains

Mr F E Reynolds has been appointed lecturer in neuro-pathology in accordance with an agreement between the Board of Scottish Asylums and the University Dr Henry Wade has been promoted a senior lecturer in clinical surgery

Mr W. L Ferrar, lecturer in mathematics, has resigned on his election to a fellowship at Hertford College, Oxford. Dr J E Macartney, lecturer in bacteriology, has resigned on his appointment as Director of Pathological Services to the Metropolitan Asylums Board

MANCHESTER.—Applications are invited from British-born subjects, either born in or inhabitants of the county of Lancaster, preference being given to the county borough of Rochdale, for the Sir Clement Royds Memorial scholarship in chemistry, the value of which is 300*l*. The applications must reach the Internal Registrar not later than June 1

THE development of Indian universities formed the subject of a paper read by Sir Henry Sharp before the Royal Society of Arts on March 6 and recently published in the Society's Journal. The author, who has only recently left the Indian Educational Service after belonging to it for nearly thirty years, has for many years been the chief official adviser of the Government of India in educational matters. He dealt with the subject from the point of view of the historian rather than that of the educational politician, but in the discussion which followed opinions were freely expressed as to the merits of past and current educational policies It was pointed out that because universities had grown up with a literary bias, technological institutes had not flourished as they should have done. In recent years attempts have been made to develop technical education in subordination to universities in order that technological students may qualify for university degrees This Sir Henry Sharp regards as unfortunate He would rather see such institutions as the Sydenham College of Commerce in Bombay growing up along their own lines independently of universities. Sir Edward Gait directed attention to the fact that the vast majority of Indians hold that, whatever else it may be, education must be cheap, and that a university degree, as the necessary passport to remunerative employment, must not be very difficult to obtain. This has led to the abandonment of the promising scheme accepted by the Government of India, before the introduction of dyarchy, for replacing the obsolete Patna College buildings on a crowded site in the heart of the city, where the true university spirit can never be developed, by new buildings on a spacious site outside the city. The plan was abandoned on the ground that it would place an honours course beyond the means of the poorer students.

Early Science at Oxford.

May 12, 1685. Mr Ballard gave in an account of Mr Desmaister's Experiments about ye mixture of spirits of wine with Syrrup of Violets, Milk and Water It was desired by the Society, that some farther Essaies should be made towards the finding out of the Nature of the Spirits of severall sortes of Wines and other liquors From these therefore following I have drawn and rectified their spirits, viz. Sacks—Canary, Malaga and Sherry, Rhenish, new and old Hockamore, Pont, white-Wine, and Clarret These were all distilled, some three, some four times, without addition of any thing, and therefore could not (though in high Bodies, and with a spunge at the top) be quite fined from their phlegm Every one of these without any discernible difference made a like coagulation of the milk with ye simple and pure spirits of wine Several of Kunkel's experiments were not found true

May 13, 1684. Dr Smith, takeing ye Chair, communicated an abstract of a letter from Paris, which sayes that there is a Thermometer, lately invented there by Monsr du Val, (whose father, a famous architect, contrived ye church of Val de Grace) which serves to shew ye duration, increase, and diminution of feavors It is but 3 inches long, 4 or 5 lines in diameter, ye inner pipe, which contains ye refined quicksilver, is onely half a line in diameter

Letters from Mr Aston, and from Mr Molineux, and ye Dublin Minutes were read On ye account of these Minutes some of St Cuthbert's beads were produced by Dr. Plot they were not perfect screw stones (as they are commonly termed) but a conjunction of Annulets, sometimes hollow, (some of which sort have been used as beads) and may be separated from one another, by lying in vinegar Mr Molineux is desired to inform us as to ye nature of ffelns *i.e* a Tumor growing on ye extream parts, and proceeding (as it is supposed) from ye use of whey

An abstract of a letter from Mr Heathcott, from Cabo Cors, on ye coast of Guinea, to Mr Flamsteed, concerning ye Tide on that coast, ye variation of ye needle, &c, was read

An account of some Injections into ye thorax of a dog, was read by Mr Musgrave "On Thursday ye 21st of June 1683, I syring'd ℥iij of warm water, into ye right side of a Grey-hound bitch, which causd a great *Rigor*, (especially in ye hinder parts,) a shortness of breath, a heat, or burning, in ye flesh, she look'd heavy, was unwilling to rise, or stand long on her feet, these Symptoms wore off by degrees, so that in a week's time she appeared as well as ever" Similar injections were made on July 2 and 15 "They all went off, and in five days time she seemed perfectly recovered"

"Thus, we see, a quantity of lbiij½ of warm water, has been injected into ye middle venter of ye same Grey-hound, within ye space of one month, & if we may be allow'd to judg of her recovery, by a perfect cessation of all Symptoms, as to outward appearance, we must then grant, that this water was carried off thence, in that time, but to give an account, which way it was discharged, (whether by Expiration, Perspiration, Seige, or Urin,) seems very difficult, and is beyond my Anatomy to explain"

Certainly these experiments, as also ye many histories of Empyemas and Dropsies of ye brest mentioned by physitians as cured by large evacuations of urine, doe, in some measure, argue ye probability of a passage or *Ductus* from the thorax, which may convey off thence what liquor arises, either from ye condensation of vapors, or from ye rupture of lymphatics, or any other way in that cavity, mediatly or immediatly, into ye blood

Societies and Academies.

LONDON

Geological Society, March 25.—C B. **Brown** and R. A. **Baldry**. On the clay pebble-bed of Ancon (Ecuador) This bed, varying in thickness from 550 to 900 feet, crops out on the southern shore of the Santa Elena Peninsula, Ecuador It consists of polished, rounded, or sub-rounded pebbles of harder clay, embedded in a matrix of softer clay, and contains large and partly rounded boulders of sandstone, foraminiferal limestone, grit, polished quartz-pebbles, etc., and masses of limestone It is considered to be the result of a great post-Oligocene overthrust in soft sands and clays of Tertiary age The direction of thrusting is from the east-south-east (the Brazilian over the Pacific block).—J I **Platt**. The pre-Cambrian volcanic rocks of the Malvern inlier. The region described occurs about the central part of the Malvern Range, and consists largely of volcanic rocks, which are of pre-Cambrian age, and belong to a distinctly sodic suite comprising soda-rhyolites, keratophyres, and spilites There are a few pyroclastic rocks developed Although those examined were of an acid composition, there can be little doubt that more basic types also occur A number of minor intrusions have been injected into the lavas In the south-west of the area described, two dykes of a comparatively fresh ophitic dolerite crop out, while a subophitic variety of the same type is found in the north-west There are several dykes and a volcanic neck of epidiorite in the east of the area

Aristotelian Society, April 20.—Jessie **White** The relation of pedagogy to philosophy The science of pedagogy, like other sciences, depends on observation, experiment, and reflection on their results. It starts with assumptions (1) that immature individuals with marked differences, qualitative and quantitative, can be aided or obstructed in their development by the nature of their material environment and by the actions of the persons with whom they are in contact, (2) that in normal infants there is a powerful impulse towards loving and learning, and these are processes which each individual must engage in for himself with suitable help from others, (3) that relatively to the child there is "a ready-made systematised classification of the facts and principles of the world of nature and man" (Dewey), (4) that schooling is only part of the educative process and must be viewed in relation to that wider process

MANCHESTER.

Literary and Philosophical Society, March 17.—W W C **Topley** The bacteriophage phenomenon—transmissible bacterial lysis The lytic principle is an ultramicroscopic parasite, because it is particulate in Nature, has the power of reproduction through an endless series of subcultures in symbiosis with a sensitive bacterium, and possesses a certain power of adaptation It is not a living organism, because it can only increase in amount when the sensitive bacterium is actually dividing, a limitation which is not in accordance with most known facts of infection, because it can be precipitated by such agents as acetone or aluminium hydroxide and be recovered in an active form by solution in such substances as acetic acid or ammonia, and because its heat-resistance and persistent activity on prolonged storage suggest a chemical substance rather than a living organism. All the latter characteristics are, however, quite compatible with the active substance being a ferment, but a ferment cannot reproduce itself, so that we should have to believe that the organisms themselves produced more of the ferment when they were undergoing destruction by it. This mechanism would seem to lead to race suicide; yet the bacteriophage and sensitive bacteria are widely distributed in Nature.

PARIS.

Academy of Sciences, March 30.—Émile **Picard**: Some singular integral equations.—Ch. **Lallemand**: A supposed sinking of the soil in France On the basis of geodesic work by Bourdaloue, done in 1857–1864, and by Ch Lallemand in 1884–1893, Schmidt has concluded that in the neighbourhood of Lille the ground has fallen by about 1 metre, and this sinking is proceeding at the rate of 25 mm. per annum This view is accepted by E Kayser, who considers the differences cannot be regarded as within the limits of the experimental error. A study of the records of the self-registering tide recorders at Brest and at Marseilles does not reveal this difference, which the author concludes must be attributed to systematic experimental errors in Bourdaloue's observations.—Marcel **Brillouin** The external field of gravitation and internal densities.—Ch **Moureu**, Ch **Dufraisse**, and P **Lotte** Auto-oxidation and antioxygen action. The catalytic property is localised in the oxidisable part of the molecule of the catalyst In the case of sulphur compounds a relation has been established between the oxidisability of the catalyst and its antioxygen action Thus whilst mercaptan and alkyl sulphides act as powerful antioxygen catalysts towards furfurol, the corresponding sulphones are devoid of such action.—P **Widal**, P **Abrami**, **Diaconescu**, and **Gruber** Digestive hæmoclasia and variations of the neuro-vegetative tonus.—André **Blondel**. Acoustic selection and radiogoniometry. A discussion of the best means of utilising wireless telephony from light-houses as a means of warning vessels at sea during fog.—E. **Mathias**, C A **Crommelin**, H Kamerlingh **Onnes**, and J. C. **Swallow**. The rectilinear diameter of helium The observed values of the densities of the liquid and the saturated vapour of helium are given for nine temperatures between −268°·38 C and −270°·79 C. The formula for the rectilinear diameter is $z = -0{\cdot}40263 - 0{\cdot}0017616\ \theta$ The deviations from the straight line are small, although a little larger than those found for hydrogen and neon.—Ladislas **Nikliborc** Hyper-harmonic functions.—St. **Kempisty**. The integration of measurable functions.—— **Gossot** and — **Liouville**. The principles of interior ballistics.—J **Cojan** New extension of the method of zones (Ritchey) to the determination of aberrations outside the axis.—G **Bruhat** and M **Pauthenier**: The measurement of the dispersion of carbon disulphide in the ultra-violet.—Fernand **Prothais**. Study of the mixer of gas pumps at low pressure.—Mme. J. S. **Lattès**: The decomposition into definite groups of the total radiation of radium, by absorption in platinum.—A. **Baldit** An alignment of radioactive springs in the region of Velay (Haute-Loire). Out of seventeen mineral springs in this district which have been examined, only three show radioactivity, those of Sembadel, Les Estreys, and Bonnefont, and these three springs are shown to be in a straight line. A fourth radioactive spring (Ceyssoc) was discovered in January 1925, and this is exactly on the line joining the other three.—L. **Chassevent**: The velocities of crystallisation of gypsum and the preparation of plaster of high resistance.—Mlle. J. **Lévy** and Roger **Lagrave**: Comparison of the migratory aptitudes of hydrogen and some radicals of the acyclic series.—J F. **Durand** and Sherrill **Houghton**: The reduction of nitro-derivatives by calcium hydride. Calcium hydride reduces nitrobenzene to nitrosobenzene, then to azoxybenzene. Nitromethane gives a calcium salt without reduction.—C. E. **Wegmann**: The orogenic

phases of the Scandinavian Caledonian chain.—Iovan **Cvijic**: Karstic types of transition.—Raoul **Bélus** and Léon **Maurel**: Magnetic measurements in the south of France.—P. **Bugnon**: Leaf homologies in the sweet violet.—L. **Lutz**: The specificity towards their supports of the fungi of the group of *Pleurotus Eryngii*. The growth of the fungus is controlled by the presence or absence of antagonistic substances in the plant: the fungi behave more as saprophytes than as true parasites.—M **Bridel** and C **Charaux**: Rhamnicoside, a new glucoside, the generator of Chinese green, extracted from the bark of the stem of *Rhamnus cathartica*. Details of the isolation and physical and chemical properties of this new glucoside are given. Its composition is $C_{20}H_{30}O_{15}.4H_2O$, and on hydrolysis with dilute sulphuric acid gives glucose, xylose, and rhamnicogenol. The glucoside in alkaline solutions, in the presence of air and light, gives Chinese green.—Raphael **Dubois**. The nutrition of the Bromeliaceæ without roots. *Tillandsia dianthoides* (the air flower) has been regarded as a carnivorous plant, but observations are given which prove that this view is incorrect.—G. **André** and E. **Demoussy**: The selective absorption of potassium by plants.—Gustave **Rivière** and Georges **Pichard**: Comparative trials between the efficacity of nitric nitrogen, employed alone, and ammoniacal nitrogen in the presence of partial soil sterilisers.—M. and Mme. Louis **Lapicque**. A new demonstration of the equality of chronaxy between striated muscle and its motor nerve.—Jean **Delphy**: The fixation and contractibility of some Infusoria.—Émile F. **Terroine** and Jean **Roche**. The causes of the differences of the intensity of elementary respiration of the tissues.—Mme L. **Randoin** and Mlle A. **Michaux**: Variations in the proportion of urea in the blood of the guinea-pig under the influence of a diet lacking the anti-scorbutic factor.—Auguste **Michel**: Metamerism and muscular elements in *Scoloplos armiger*.—W. **Mestrezat** and Mlle. Y. **Garreau**: Experimental contribution to the study of the transit of electrolytes. Velocity of diffusion through a septum and ionic selection.—Raoul M. **May** and S. R. **Detwiler**. The nerve relations of transplanted eyes with the nerve centres in course of development in *Amblystoma punctatum*.—Ph. **Joyet-Lavergne**: The evolution of the lipoids and the sexualisation of the cytoplasm in the Sporozoa.—H. **Foley** and M. **Brouard**: Demonstration of the efficacity of the daily administration of quinine in small doses for reducing the virus reservoir in malaria of natives (southern Algeria).—Edmond **Sergent** and H. **Rougebief**: New experiments on the dissemination of yeasts in the vineyard by drosophiles.

ROME.

Royal Academy of the Lincei, February 28.—Secondo **Franchi**: The secondary inversion series and the large overthrusts in the Albenga Mountains (Ligurian Alps).—Eduard **Čech**: Projective geometry of bands of contact elements of the third order.—Francesco **Sbrana**: A proposition of Almansi.—Giovanni **Vacca**: Euler's constant, C = 0·577 . . . .—Ugo **Broggi**: Theory of repeated proofs.—Bruno **Finzi**: Lord Rayleigh's dissipation function.—Francesco **Vercelli**: Results of the cruise of the *Marsigli* in the Straits of Messina. The construction of general tables of the currents for nautical purposes is described.—Franco **Rasetti**: Duration of the quantic state $2p_3$ of the mercury atom.—Giorgio **Piccardi**: A thermal method for the study of gaseous systems.—P. **Leone**: Organo-metallic compounds of aluminium. Aluminium alkyl halides behave similarly to the corresponding magnesium compounds towards ammonia and primary and secondary amines, the hydrocarbon being liberated and the nitrogen becoming directly attached to the metal.—Arrigo **Mazzucchelli** and Angelina **Vercillo**. Preparation of intermetallic compounds by the wet method. Reference is made to a number of instances in which an alloy is formed by the interaction of salts of the component metals in aqueous solution.—Bernardo **Oddo**: Methylketole yellow. This name is proposed for potassium 2-methylindyl-2-methylindolidenephenylmethane-o-carboxylate, which imparts to wool and silk a bright yellow colour stable towards acids.—U. **Pratolongo**: Notes on pedological chemistry. (1) The alkalinity of the soil in its relations to the lithological constitution. The high degrees of constitutional alkalinity (P_H 8·8–9·2) exhibited by certain soils are, contrary to what was formerly a common supposition, not derived from calcite or aragonite, possibly hydromagnesite is the determining factor.—Mario **Amadori**. Hydrated mesotartaric acid.—Antonio **Cavinato**. Studies on quartz. Corrosion phenomena in a quartz crystal from the Miage glacier (Mont Blanc).—A. **Spartà**: New species of Phyllirhoe (Berg) *Phyllirhoë Sanzoi*.

VIENNA.

Academy of Sciences, February 19.—G. **Kirsch** and H. **Pettersson**: Atomic disintegration by α rays (Preliminary communication). The H-particles and reflected α particles given off by 25 elements under bombardment by swift α particles and at wide angles (about 140°) with the direction of incidence were investigated by methods previously described. The fact already found for nickel and copper, that the reflected α particles have a smaller range than that calculated by Rutherford's theory assuming elastic impact, is confirmed for the elements investigated. For all the lighter elements, including chlorine, the reflected α particles seem to be almost completely missing even at ranges of only 0·5 cm. For vanadium, chromium, iron, selenium, and iodine the departures from the theoretical values are particularly large. Retrograde H-particles have been found with certainty from the elements beryllium, carbon, oxygen, magnesium, aluminium, chlorine, titanium, vanadium, chromium, iron, copper, selenium, and zinc.—F. **Hettwer**: The viscosity of certain metals. By prolonged torsion of rods of lead, tin, aluminium, and zinc, the effect of viscosity could be distinguished from the elastic after-effect. The coefficient of viscosity for these metals was found to be between 5×10^{14} and 3×10^{16}. For lead-tin alloys no viscosity effect was detected.

March 5.—H. **Michel** and K. **Przibram**: Blue zircon from Siam and its behaviour to Becquerel rays. For some years there has come from the neighbourhood of Muang Chantaboon in Siam, some 198 kilometres north of Bangkok, a blue zircon occasionally called Siamese aquamarine. This blue zircon, the crystal form of which is described, develops, when kept in the dark, flesh-coloured spots which disappear in the light. The possibility of these spots being due to radioactivity often associated with zircon made it desirable to study the action of Becquerel rays on this mineral. Under β γ radiation the blue changes through flesh colour to dark brown often in striæ parallel to certain cleavage-planes. The blue colour is restored by heat and light. Qualitative observations on the radio-luminescence, thermo-luminescence, and radio-photo-luminescence are recorded.—J. **Weise**: Chrysomelidæ and Coccinellidæ, beetles from the Anglo-Egyptian Sudan, being Part xxiii. of the scientific results of F. Werner's expedition.—H. **Wichmann**: The ecology of *Xyloterus lineatus*, a wood beetle obtaining its food from symbiotic fungi.

Official Publications Received.

Proceedings of the Royal Society of Edinburgh, Session 1924–1925. Vol. 45, Part 1, No. 5: The Ionisation of Iodine Vapour by Ultra-Violet Light. By W. West and Dr. E. B. Ludlam. Pp. 34-41. 1s. Vol. 45, Part 1, No. 6: Experiments and Observations on Crustacea. Part 6. The Mechanism of Massive Movement of the Operculum of *Paludina nubilis*. By Dr. John Tait and Dr. W. F. Emmons. 1p. 42-47. 9d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 13, No. 5: The Eradication of *Cyperus rotundus* L. (A Study in Pure and Applied Botany.) By S. B. Ranade, arranged and written by Dr. W. Burns. Pp. 99-192+8 plates. 2 4 rupees, 3s. Botanical Series, Vol. 13, No. 6: Studies in Diseases of the Jute Plant. (2) *Macrophoma corchori* Saw. By Dr. F. J. F. Shaw. Pp. 193-198+2 plates. 8 annas, 9d. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.)

Canada. Department of Mines. Mines Branch. Investigations of Mineral Resources and the Mining Industry, 1923. Pp. 74. Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1923. Pp. 75. Investigations in Ore Dressing and Metallurgy (Testing and Research Laboratories) 1923. Pp. 150. Investigations of Fuels and Fuel Testing (Testing and Research Laboratories) 1923. Pp. 80. (Ottawa: F. A. Acland.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1924. Pp. v+167+22 plates. (Hobart.) 10s.

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Edited by Prof. Walter Howchin, assisted by Albert H. Elston. Vol. 48. Pp. iv+350+32 plates. (Adelaide.)

New South Wales. Botanic Gardens, Government Domains, Garden Palace Grounds, Centennial Park and Campbelltown State Nursery. Report of Director for 1923. Pp. 7. (Sydney: Alfred James Kent.) 7d.

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1924. Pp. ii+9. (Cape Town: *Cape Times*, Ltd.)

The National Physical Laboratory, Teddington, Middlesex. Metrology Department. Verification of Weights, Testing of Balances, Determination of Densities. Pp. 28. (Teddington: National Physical Laboratory.) Free.

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1924, presented to the Annual Meeting, February 9th, 1925. Pp. 46. (York: Yorkshire Museum.)

Arkiv för Matematik, Astronomi och Fysik utgivet av K. Svenska Vetenskapsakademien. Meddelande från Lunds Astronomiska Observatorium. No. 105. Die Ausmessung des Sternhaufens ICN 4996. Von W. Gyllenberg. Pp. 48. No. 106. A Contribution to the Problem of Determining the Distribution in Space of the Stars. By K. G. Malmquist. Pp. 12. No. 107: Remarks on the Absolute Magnitude Curve. By K. G. Malmquist. Pp. 4. No. 108: *On the Correlation between Proper Motions* and Radial Velocities. By W. Gyllenberg and K. G. Malmquist. Pp. 86. (Stockholm: Almqvist and Wiksells Boktryckeri A.-B.; London: Wheldon and Wesley, Ltd.)

Department of the Interior. Bureau of Education. Bulletin, 1924, No. 30: Land Grant College Education, 1910 to 1920. Part 1: History and Educational Objectives. Edited by Walton C. John. Pp. vii+51. 10 cents. Bulletin, 1924, No. 40: Legal Provisions for Rural High Schools. By William R. Hood. Pp. 60. 10 cents. (Washington: Government Printing Office.)

British Legion. Annual Report and Accounts, 1924. Pp. 97. (London: 26 Eccleston Square, S.W.1.)

Smithsonian Miscellaneous Collections. Vol. 77, No. 3. *Provisional* Solar-Constant Values, August 1920 to November 1924. By C. G. Abbot and colleagues. (Publication 2818.) Pp. 38. (Washington: Smithsonian Institution.)

Diary of Societies.

SATURDAY, MAY 9

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (I.).

MONDAY, MAY 11.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr. F. A. E. Crew: Unilateral Vasoligation on the Senile Male of the Domestic Fowl. Miss Sheina M. Marshall: A Survey of Clyde Plankton.—Miss Frances M. Ballantyne: The Continuity of the Vertebrate Nervous System: Studies on *Lepidosiren paradoxa*. E. B. Bailey: Perthshire Tectonics. Loch Tummel, Blair Atholl and Glen Shee.

BIOCHEMICAL SOCIETY (at Middlesex Hospital, W.1), at 5.—S. L. Baker: *Intra-renal Obstruction caused by the Products of Hæmolysis.*—R. W. Scarff: Experimental Atheroma in Rabbits produced by Cholesterol Feeding.—O. Rosenheim and Prof. J. C. Drummond: A Delicate Colour Reaction for the Presence of Vitamin A.—E. H. Lepper and Dr. C. J. Martin: The Influence of Salt Concentrations on the C_H of Buffer Solutions as indicated by the Electrometric and Colorimetric Methods respectively.—H. W. Kinnersley and R. A. Peters: Antineuritic Yeast Concentrates.—L. Gross and P. Eggleton: Note on Blood Sugar Levels in Rats fed on Complete Diets and Diets deficient in Vitamin B.—Dr. T. A. Henry, T. M. Sharp, and H. C. Brown: Bacteriolidal Action of some Organic Compounds of Mercury.—F. Dickens, E. C. Dodds, and S. Wright: Observations upon the Preparation, Properties, and Standardisation of the Ovarian Hormone.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: Some Effects of Climate on the Circulation (IV.).

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss B. Low: Some Considerations on the Cinema in Education.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. K. J. B. Philby: The Dead Sea to Aqaba.

MEDICAL SOCIETY OF LONDON, at 8.—Sir Bernard Spilsbury: The Medical Career of John Keats (Annual Oration).

INSTITUTE OF BREWING (London Section) (at Engineers' Club, Coventry Street, W.1).—H. Abbot: A Review of the Carbonating Process as applied to Beer.

TUESDAY, MAY 12.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—H. W. Lee: The Principle and Construction of the Telephotographic Lens.—E. Marriage and others: The Applications of the Telephotographic Lens.

WEDNESDAY, MAY 13.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology) (Section of Surgery) (Annual General Meeting), at 5.

ROYAL SOCIETY OF ARTS (Jointly with the Royal Aeronautical Society and the Anglo-Batavian Society), at 8.—T. A. T. Van der Hoop: The Flight to the Netherlands East Indies.

THURSDAY, MAY 14.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 4.30.—Prof. S. Nicholson. The Malas, an Outcaste People of S. India.

ROYAL SOCIETY, at 4.30.—Prof. E. C. C. Baly and Elizabeth Semmens: The Selective Photochemical Action of Polarised Light. I. The Hydrolysis of Starch.—R. B. Thomson and H. B. Sifton: Resin Canals in the Spruce (Picea). An Anatomical and Orcological Study and its Bearings on Phylogeny.—H. G. Cannon: On the Segmental Excretory Organs of certain Freshwater Ostracods.—E. G. T. Liddell and J. F. Fulton. Observations on Ipsilateral Contraction and "Inhibitory" Rhythm.—K. Furusawa: Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen. Part X. The Oxygen Intake during Exercise while breathing Mixtures rich in Oxygen.—*To be read in title only.*—J. S. Yeates. The Nucleolus of *Tmesipteris Tannensis* Bernh.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 5.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. J. Fleure: Prehistoric Trade and Traders of the West Coasts of Europe (II.).

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—F. W. Preston: (*a*) The Fundamental Law of Annealing, (*b*) The Dimensional Accuracy of Mr. Hampton's Paper on "The Annealing of Glass."—T. Smith: A Note on the Cosine Law.—W. Watson and Sons, Ltd.: Exhibition and Description of Recent Types of Apparatus and Instruments including: A new Student's Model Microscope, Greenough Microscope with Special Attachment for Instantaneous Conversion into a High Power Binocular Microscope.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.2), at 8.—P. May: Artists' Colours.

FRIDAY, MAY 15.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (Annual Meeting), at 5.—Discussion on High Voltage and other Radiotherapy.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Discussion on Art or Truth?

PHILOLOGICAL SOCIETY (at University College), at 8.—Prof. E. Weekley: Some new Etymologies.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—E. N. Fallaize: Problems in Eugenics, and the Study of Primitive Races.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. C. G. Darwin: Recent Developments in Magnetism.

SATURDAY, MAY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth. Byron and Italian Literature (II.).

FREE PUBLIC LECTURES.

MONDAY, MAY 11.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: Hegel's Æsthetics. (Succeeding Lectures on May 18, 25.)

TUESDAY, MAY 12.

GRESHAM COLLEGE (Basinghall Street, E.C.2), at 6.—A. R. Hinks: Timekeepers and Time Signals. (Succeeding Lectures on May 13, 14, 15.)

LIVERPOOL UNIVERSITY, Sir Robert Jones: Crippling due to Fractures: its Prevention and Remedy (Lady Jones Lecture).

WEDNESDAY, MAY 13.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—R. A. Smith: Primitive Man. (Succeeding Lectures on May 20, 27.)

THURSDAY, MAY 14.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries in Egypt.

ST. MARY'S HOSPITAL: Institute of Pathology and Research, at 5.—A. T. Glenny: The Principles of Immunity as illustrated by Protective Inoculation against Diphtheria.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir W. Watson Cheyne, Bart.: Lister Memorial Lecture.

FRIDAY, MAY 15.

CHARING CROSS HOSPITAL MEDICAL SCHOOL, at 5.—Prof. E. Brouwer: The Projection of the Retina in the Brain.

ST. BARTHOLOMEW'S HOSPITAL MEDICAL COLLEGE, at 5.—Dr. H. H. Dale: Chemical Control of certain Bodily Functions. (Succeeding Lectures on May 19, 22, 26.)

Supplement to NATURE

No. 2897 MAY 9, 1925

The Centenary of Huxley.

THE centenary of the birth of Thomas Henry Huxley on May 4, 1825, is an event which may very appropriately be marked in a special way in NATURE. The first issue of this journal, in November 1869, opened with a translation by Huxley of Goethe's rhapsody "Die Natur"—an introduction which compelled thought and the full meaning of which was, therefore, not widely understood. He referred to this in an article entitled "Past and Present" contributed to the issue of November 11, 1894, and suggested that if such a prose poem was not intelligible to many readers it was because "At that time, it was rare for even the most deservedly eminent of the workers in science to look much beyond the limits of the specialty to which they were devoted, rarer still to meet with any one who had calmly and clearly thought out the consequences of the application, in all the regions into which the intellect can penetrate, of that scientific organon, the power and fruitfulness of which, within their particular departments, were so obvious." With the exception of a critical review in the *Nineteenth Century* of Lord Balfour's "Foundations of Belief," the article was the last pronouncement of his faith in biological evolution and the idea of human progress through the use of scientific knowledge. A few months later, on June 29, 1895, he passed into the stillness of death.

So long ago as 1874 Huxley was included among our "Scientific Worthies," and Dr. Ernst Haeckel then gave an appreciative account of his biological work. Some of the aspects of this work are displayed in the articles with which leading authorities in particular fields have favoured us for this commemorative issue of NATURE; and most of our volumes afford further evidence of its value. The range of his papers extended literally from Medusæ to man, and at both these limits his observations and interpretations endure as permanent points of reference. He was only twenty-five years of age when he returned from his voyage as assistant surgeon and naturalist on the surveying ship *Rattlesnake*, yet his work was of such merit that he was elected a fellow of the Royal Society in the following year, and at twenty-seven was a Royal medallist, member of the Council of the Society, and in the very front of British scientific men. The hundred or so papers recorded in the Royal Society Catalogue, and the four volumes of his collected scientific memoirs, are a sufficient monument of his original contributions to science, without reference to his essays, addresses, and other publications.

However great the significance of this work, Huxley's influence extended far beyond the field in which it was understood. In the mind of the public he takes his place among great thinkers not because of his scientific papers but because of his advocacy of the use of scientfic methods and results. "There are," he said, "two things I really care about—one is the progress of scientific thought, and the other is the bettering of the condition of the masses of the people by bettering them in the way of lifting themselves out of the misery which has hitherto been the lot of the majority of them" It is not often that a scientific leader associates himself so closely with problems of citizenship and civilised society; and there are some who think that the time devoted by Huxley to mankind might have been given more profitably to science. If he had done so, the list of his original papers would have been extended, but public recognition of scientific truth would have been delayed for a generation. For the intellectual freedom and social position which we possess to-day, we have to thank Huxley's public work, and not his contributions to the publications of learned societies.

Just as light is invisible until it comes in contact with matter, so scientific discovery has to touch human life before the majority of people can see it. Huxley made science of human interest whether he was describing a piece of chalk or applying scientific methods to considerations of social advance or religious doctrine; and it is on this account that his memory is cherished wherever men believe in progressive knowledge and the making of their destiny through it. There is no one to-day upon whom his mantle may be said to have fallen, yet the need of declaring his message is as great as ever it was. What was once a gospel to be proclaimed from the housetops has become almost an esoteric cult, and its disciples leave the throbbing world outside their temples to look after itself. There is plenty of didactic science, but little of the vital spirit of scientific truth or of the guidance which scientific methods may afford the community. The best tribute that could be paid to Huxley upon this occasion of his centenary would be to follow him along the road he trod so fearlessly with his face always towards the light.

Home Memories.

By Leonard Huxley, LL.D.

THE editor of Nature asks me for some personal reminiscences of my father in commemoration of this his centenary birthday. Vivid indeed are those memories across the intervening years; vivid as the afterglow on the mountain peaks above the valley on which night has fallen. Among the wavering, inconsequent recollections of childhood he seems to stand as the ultimate pillar of the house; the power, rarely invoked but irrevocably right, which lay behind the round of daily governance, and, all question of personal affection apart, was hedged round with something of the awe of decision and the majesty of infallible justice. The keen eye, the firm lips which could be severe as well as tender, demanded the wholesome sincerity they offered. I do not believe any one of us seven ever tried to "get round" him, not even (I speak under correction) my youngest sister, who enjoyed, and I fear was sometimes encouraged by us to trade upon, certain privileges as the babe of the family.

His influence upon those familiarly close to him was due to the fact that he was thus sincere and true in word and deed, not that he talked about sincerity and truth in large phrase or "high-falutin" platitude. It was enough that word and act were winged with such attributes. They worked of their own essence from within, where abstract preachments might well have been unable to penetrate and perhaps provocative of reaction.

But if we knew how firm that decision of his could be, we knew also its constancy and lasting support It was a thing that awakened along with awe, not sulks, but respect.

The companionship between parent and child, so prevalent to-day, was unknown a century ago and rare fifty years since. Though he had a great love for children, my father saw less of his own than he could have wished. In the endless rush of his strenuous life he left home early and returned late. The day was filled, and overfilled, with professorial work in the lecture-room and the laboratory, with Royal Commissions and the affairs of learned societies, and later, the School Board, punctuated with meetings of societies and public lectures and addresses and some measure of social intercourse with his friends, among whom his warmth and brilliance were always welcomed. Every spare moment of the day that could be found was devoted to his own researches; the nights he was at home he was back at his books or his writing by half-past eight for three or four hours, at one period winding up the day with a long read in bed at some stiff work on philosophy. If Sundays brought relief from professorial duties, they offered certain free hours for writing, and when the summer holidays took us all to the sea, the mornings were always spent in steady work. In fact, so curtailed were his home hours when we were children, that he used humorously to describe himself as "the lodger"

Still, there were many Sunday mornings, more often, it seems to me, than Sunday afternoons, when in the early 'seventies he used to take us three elder ones a cheerful walk, either up the green lanes, as they then were, that led to Hampstead Heath, or to the more thrilling delights of the Zoo, where his position in the Society and his frequent collaboration with the Prosector, made him well known to all the officials Under his ægis we were sometimes given baby lions to pet, or taken into the inner rooms of the monkey-house and allowed to walk hand in hand with pleasant chimpanzees which were too delicate to be exposed to the infectious perils of the open monkey-house before the secrets of tuberculosis were discovered

On these walks, whether in town or country, he never laid himself out to be didactic, after the model of Mr. Barlow or of one scientific friend of his own, who, I fancy, sometimes induced the wrong kind of reaction in his children by what they felt was unseasonable instructiveness. Not but what we picked up various golden crumbs casually, sea stories we might have, and tales of animals, and occasionally geological sketches suggested by the gravels of the Heath; only these things were not openly pressed upon us. I know that he wanted us to grow along our own intellectual bents, and had a real horror of forcibly bending the twig from without by untimely pressure of his own special interests. At all events, what we got provoked interest, not reaction. I have no doubt we could have borne more without reaching the saturation point he dreaded.

Even in the earlier days of hurry and stress, memory recalls precious quarters of an hour before bedtime when he drew pictures for us, for he was, if untrained, a skilful draughtsman by nature, either in pencil or with coloured chalks on brown paper. Curiosity was kept on the tenterhooks of fearful expectation; if we clamoured to know what was coming next, there was the invariable warning that the pencil might take control and produce something portentous and unspeakable. It was an unforgettable disappointment when, one evening during convalescence after scarlet fever, I fell asleep too early and missed the eagerly looked-for chapter in the veracious history, so richly illustrated, of Mr. Bull Terrier and his family on holiday at the seaside.

Dinner on Christmas Day had a joy of its own, for before our eyes he invariably carved wondrous beasts out of orange peel, mostly pigs with crooked legs, but also elephants and well-paunched apes. At the time when Whistler was stirring the Academic pool with his nocturnes and harmonies, one of these masterpieces was solemnly ticketed "A Piggurne, or a Harmony in Orange and White."

The published letters offer touching evidence of his own love for children and of his realisation of the part they play in the life of the human affections. Two in particular stand out one to Charles Kingsley on the death of his own little boy, the other to his eldest daughter when her child died

In the years of his retirement and greater leisure, his grandchildren came in for these good things Congratulating a friend on the birth of a grandchild, he wrote: "I forget whether you have had any previous experience of the 'Art d'être Grandpère' or not —but I can assure you, from 14 such experiences, that it is easy and pleasant of acquirement, and that the objects of it are veritable 'articles de luxe,' involving much amusement and no sort of responsibility on the part of the possessor." Unhampered by circumstance, his love of children brimmed over with merry nonsense and suggestive good sense. I always like the story of how a visitor arrived to find him on hands and knees with a big sheet of paper spread out on the floor, drawing a plan of the solar system for a small grandchild. And what could be more perfect of its kind than the letter about the Waterbabies to his yet smaller grandson, with the hope that he also would grow up to be "one of the great-deal seers"?



Photo] [*Vaul and Polyblank.*

1857.

True, perhaps, that a shy child, conscious of the gulf between what happens and what ought to happen, and distrustful of his own powers, might be more acutely aware of the awe and authority which invested his rare presence than of the comparatively reticent affection that became better known afterwards. Afterwards, too, one learnt that with all his strictness against moral lapses, he could make pitiful allowance for the temptations of nature and temperament

I think that of all forms of immorality —and naturally he avoided that unscholarly euphemism which delicately restricts the word to the least delicate breaches of the moral code—he hated most the lie, dishonesty of word or act Veracity he felt and knew to be the very foundation not only of intellectual but also of moral and social life Firmly and inevitably he broke off relations with people whom he found he could not trust, no matter how close their former association, or how powerful their influence in the world where he moved. Indeed, against a lively talker who argued that truth was no virtue in itself, but must be upheld for expediency's sake only, he declared himself to be "almost a fanatic for the sanctity of truth." Even a noble perjury like that of John Inglesant for his king, was a "moral suicide" If a man allows himself to be believed worse than he actually is, it is a loss to the world of moral force, which cannot be afforded. Yet I remember once, when the conversation turned on the occasions when lying might conceivably be justified, he confessed that it would be very difficult not to permit a lie in defence of a woman's honour, and a letter speaks gently of writing more generously of a dead man than his strict deserts for the sake of his widow.

Nor was this love of truth, when the clash came, applied only against others. If he found he had made a mistake, he admitted it frankly, without hedging or qualification. As he said on one occasion, "The most considerable difference I note among men is not in their readiness to fall into error, but in their readiness to acknowledge these inevitable lapses."

The fanatical person, the slave to creed or habit, has but a one-way traffic of mind. His logic has become inflexible; it may not be turned against himself. This at least was not my father's way, even in regard to the conventionalised acts of social life which unreasoning habit tends to make sacrosanct. True that social conventions, the courtesies and decencies of life, originally based upon valuable controls of our turbulent nature, however much they were exaggerated by that estimable lady Mrs Grundy, meant much to his orderly conception of daily life Though he would fight resolutely against the tyranny of the untrue, the irrational, and the cruel, disorder for its own sake, repudiation of the debt we owe to the society which has made our life possible, found no favour in his eyes Still, let it once be shown that there was no sound argument against the breaking down of some conventional habit, as, for example, that his daughters should not smoke equally with his sons, he put aside his prejudices fairly and squarely, admitting that they were merely conventional

In these things, as in other difficulties, his motto was Grasp the nettle A passive responsibility must be faced as promptly as an active one; and when responsibilities came his way, he was always ready to shoulder them A subconscious knowledge of this, I think, must have contributed to our sense that he was always a bulwark in case of need

In trying to analyse one's youthful feelings towards him, I think it was this living intensity of the passion for veracity which was at the bottom of the sense of awe that crept, as I have said, into our regard. Before that intensity anything weak or shuffling or insincere shrivelled painfully away. With that quality went the clearness of decision and readiness to accept responsibility which we knew, and which was reflected in his abhorrence of anonymity in written criticism; a rapidity of thought that flashed to sight of a conclusion even before it had seen all the intermediate steps; an eye that, reading at railroad speed, would tear the heart out of a book and store in the mind the substantial points of value to himself together with remembrance of the place where they might be found again for fuller reference; a fiery energy which slow-moving colleagues found almost terrifying He had a quick temper, swiftly moved by injustice, ill behaviour, ignorant aggression, or the sight of cruelty; withal he had no smallest trace of bad temper, of sullenness or grudge-bearing. Malice could not exist with the bubbling sense of humour which never deserted him, nor empty rudeness with his strong self-respect Certainly his retorts could be devastating, but they were neither unprovoked nor after the fashion of Dr. Johnson, knocking his opponent down with the butt end of the pistol after he had spent all his ammunition. They had a deadly keenness and kept close to the point at issue.

Certainly, also, he did not suffer fools gladly, and he was much pestered by them all his life Yet there are compensations even in this, for, as he exclaimed, "Of the few innocent pleasures left to men past middle life, the jamming common sense down the throats of fools is perhaps the keenest"

To do this with a neat turn of fence and a dash of humour or polished irony afforded him real artistic satisfaction. For the artist in him was very strong;—the sense of form and proportion which give not only beauty but, to a missile, penetration and to a structure, balance that is easily comprehensible. The eye which, had he followed a latent bent towards mechanics, would have made him at once engineer and architect, was quick to group his materials in their relations one to another, to seize on the essentials and to create a whole inevitably lucid, convincingly clear, which, though warmed with generous thought and enriched with wide knowledge and a clarity of words to match the clarity of ideas, seemed to be the unrolling of Nature's self for all to read; something, as it were, independent of the mere writer, something superior to the literary posturings of too many interpreters of the universe. In this sense he had the style that Buffon declared was part of a man's self, a thing that depends on inward grace, not on outward graces and laborious embellishments. Vision and expression were alike in their directness, their fullness, their clarity, their freedom from the top-hamper of the unessential. It was this quality in his lectures that led a certain literary lady and friend of the house to ask my mother why it was that his lectures were so highly praised. For her part, it seemed that he just explained the subject, and that was all about it. I do not think he ever desired higher praise than that left-handed compliment.

As to his mode of writing, it was not often that he wrote off his matter satisfactorily at the first draft. There were, of course, enough occasions, as when he dashed off the review of the "Origin of Species" as "devil" for the regular *Times* reviewer, when the inward fire and the shortness of time conspired to produce a first-rate result; but in general his proof sheets were hard work for the printer. He would prune and recast until somehow it came right, and word and phrase truly represented his meaning and tallied with fact, so that,

as he used to say, he could stand cross-examination upon it. As time went on, he became ever more fastidious in giving exact expression to his thought, for he had a great love and respect for his native language.

In return he enriched current English with vigorous coinages of his own; the word Agnostic, for example; or phrases like "the ladder from the gutter to the University" or the definition of Comtism as "Catholicism minus Christianity," or of science as just "trained and organised common sense."

The same determined care in schooling himself turned him from a wretched lecturer into the best lecturer of his generation. A letter pointing out his faults of method and delivery he preserved carefully, labelling it "Good Advice."

With this clear, quick turn of thought and speech, his current talk, his stories, his humorous touches, were all delivered with a fine economy of words, abundant yet never clogged by excess. It was impossible, remarked a friend, to imagine him ever falling into "anecdotage."

I have spoken of his drawing to amuse us as children; the artistic sense that formed his words passed also into his hand. His own father, following the odd maxim of his day that education should supply the gifts you have not instead of cultivating the gifts you have, gave him no lessons in drawing. With regular training and practice he might well have taken high rank among contemporary artists, as it was, we enjoyed the overflow of a skill rarely surpassed for drawing from memory on the blackboard anatomical details to illustrate his lectures. Various sketch-books too are filled with forcible sketches of places and figures seen on his travels and holiday excursions, and the official "Voyage of the *Rattlesnake*" is illustrated with reproductions of his drawings, though Macgillivray was careless enough to let the artist's signature appear as Hayley.

Good music he loved, though he played no instrument; and if in poetry he had no taste for formless jigging nor what he dubbed "sensuous caterwauling," he knew his Shakespeare as he knew his Goethe, and responded to the splendours of Milton, the richness of Keats, the humanity of Browning, the felicity and scientific understanding of Tennyson. Late in life he took up Greek, first to make out what Aristotle really said about his dissection of the heart as against what his commentators alleged he said, then to read the New Testament in the original; and later the early philosophers, and finally Homer. German, which he had learnt as a boy and could read as easily as French and as fast as most people could read English, he used as a key to German literature and German science. Italian he had first hammered out with a dictionary on his tropical voyages for the sake of Dante, and of Latin he acquired enough to help him through early scientific works or even, when philosophic controversy demanded, theological treatises.

The mingling of clarity and strength, of depth and gaiety, which was characteristic both of his daily talk and his less frequent letters to us, was for children simply part of the accepted course of things It was only later that its value could be realised or a comparative standard be reached by contact with others. I myself never had the fortune to attend one of his technical courses in biology, but the lectures at the London Institute which took final shape in the "Physiography" were vitalising to a child's mind, and left a lasting stimulus in quite a personal way, as if they had been part of the familiar talk we knew. As the years passed and one came to hear more lectures at the Royal Institution or elsewhere, to read his written essays, and to hear other talkers of repute, it became gradually clear how much more of what a famous headmaster called "real life" was to be got from his words than from those of others

I possess, alas, all too few records of his actual talk, though some were set down, evening by evening, during my stay at Eastbourne in the last year of his life, and are reproduced in the "Life" His talk had the quality of his personal letters, raised to a higher degree of quickness and flexibility. He never pontificated, though there was solid matter enough dissolved in the bubbling freshness of his discourse, like Cleopatra's pearl in the cup, to give it strength and memorableness, and he varied it almost instinctively to suit the interests and the personality of his interlocutor. Argument as such was never part of his table-talk, nor did he indulge in monologue; there was the give and take that is implied in the word conversation, and a swift, humorous twist of the tongue would regularly make a keen riposte playful or divert the course of what in others threatened to develop into mere argumentation, a thing not to be tolerated at a dinner table. To every place its proper code. To the great lady who told one night at dinner how she had risen and left the village church when the parson began to read the Athanasian Creed, and demanded approval of the course she had taken, he replied, "My dear Lady X, I should as soon think of rising and leaving your table because I disapproved of one of the entrées"

Knowing his consistent habit in these matters, I promptly challenged the statement made in a recently published volume of reminiscences, that the author, then a young girl, had met my father at Jowett's table, and that he had then and there proceeded to indulge in a "blasphemous tirade." My challenge extracted the singular explanation that "blasphemous" merely meant "unorthodox." Some little time afterwards I was amused to learn from my sister that on his return from Oxford he had given an account of the visit, and particularly of that same vivacious young lady he had met; but, he added, what were modern manners coming to? She had attempted to open a theological

discussion at this unsuitable place and time, and he had promptly cut it short.

One word may be permitted as to his most intimate human relations and the atmosphere that a happy union created and preserved in the home. Happy are the children who have grown up in the shelter of such a union, the strength of which lay in mutual and self-sacrificing devotion, steadfast to meet the struggles, the trials, and the distractions of long and strenuous years:—years of waiting and hope deferred, years of realisation through struggle that must either make or break character, the fulfilment of it all in the home thought from abroad: "Nobody—children or any one else—can be to me what you are. Ulysses preferred his old woman to immortality, and this absence has led me to see that he was as wise in that as in other things."

Those who have ever looked upon the "square, wise, swarthy face" of that "noticeable man" with keen, dark eyes and resolute orator's lips, a little saddened with the continued stress of ill-health, will not easily forget the expression of mingled power and sympathy which irradiated the rugged modelling of the features, the sublimation of a broad native humanity tried by adversity and struggle in the pursuit of noble ends. As Walter Besant wrote of his portrait, "There never was a face, I do believe, wiser, more kindly, more beautiful for wisdom and the kindliness of it, than this of Huxley"

Huxley.

By Sir E. Ray Lankester, K.C.B., F.R.S.

IT is a wise thing to accept and continue the long-established custom of recalling at special intervals the life-stories and noble deeds of men who in the past have done great service to our race. The memory of them—unless so refreshed—readily passes from the thought of the many. Though treasured by a few it must be continually set forth anew by the observance of festivals or "holy days," in order that the knowledge of what those great men were and did may not fade but reach the present generation as a guiding light and a source of courage and heroic action. For this reason I am glad to be able to contribute a few lines to the present number of NATURE. We are celebrating the centenary of the birth of the great naturalist, philosopher, and teacher Huxley—the apostle of Darwin, the victorious opponent of traditional ignorance and superstition, the unflinching champion of veracity.

There are among us, I regret to recognise, not a few who whilst gladly benefiting by the increased respect for science and the freedom for the expression of scientific thought which was obtained for us by Huxley, yet shrink from carrying on his uncompromising warfare against ecclesiastical authority and official nescience. The urgent need at this moment for a re-birth of the vigilance and tenacity of Huxley is shown by the aggressive action of his discredited opponents who have recently procured the legislative exclusion of the teaching of the doctrine of evolution from the public schools and colleges of certain States of the American Union. It is also shown by the hatred of Darwinism which inspires the American politician W. J. Bryan. Whilst we are at present free in Great Britain from any declared sympathy with such intolerance, we have to deplore the fact that some men—whose words are widely disseminated by the public press—profess a belief in "the occult," the wonders of "telepathy," "clairvoyance," and "spiritualistic" manifestations. The credulity of the "occultists," their neglect of the experimental method of inquiry, and their omission of exact veracious statement of the evidence for and against their conclusions, call for the attention of the younger generation since it is met with complacent indifference by most of their elders. Here there is work for them to do in the same spirit of knight-errantry as that which led Huxley in the early years of his career to attack the pretensions of clericalism and to gain an epoch-making victory for rational thought.

I desire to use this memorable occasion to urge younger men to acquaint themselves with the story of Huxley's career as told in the two volumes of his "Life and Letters" edited by his son Leonard, and by the collected edition of his essays, lectures, and addresses—in nine volumes, completed in 1894. It is in his letters and his essays and addresses on a very wide variety of topics that a reader may discover the character of the man—the convictions which directed his enterprise, and the personal charm, the humanity and gaiety of spirit which were never wanting even in his most strenuous intellectual work.

Huxley, after a course of medical studies in London, was appointed assistant surgeon in the Navy and joined the surveying ship *Rattlesnake* in 1847, when he was twenty-two years of age. He wrote and illustrated very numerous and valuable studies of the floating marine fauna now spoken of as "Plankton" which he encountered in southern seas. Some of these he sent home for publication, and brought a large number back with him at the end of 1850 when the *Rattlesnake* went out of commission. He was welcomed by Edward Forbes, Owen, Hooker, Carpenter and others who had in his absence formed a high opinion of the importance of his work and of the talents of the author. He was at once elected a fellow of the Royal Society, received the Royal Medal of the Society, and also was chosen as a member of its council.

Thus early Huxley's success was complete and exceptional as measured by the honours conferred upon him. But he failed to obtain any post or means of livelihood

beyond the small income he could make by scientific journalism and hack-work. This was a terrible trial for him, since he had become engaged to marry a lady with whose family he had formed a close friendship in Australia. It seemed to be his duty to abandon the doubtful prospect of a career in London as a man of science and to return to Australia to marry and settle down to a medical practice. He passed through a very bitter trial between 1851 and 1855. After a series of disappointments as to vacant professorships and such posts he writes to his sister: "I think of all my dreams and aspirations and of the path which I know lies before me if I can bide my time, and it seems a sin and a shameful thing to allow my resolve to be turned." Then again later he inclines to the other side and writes: "I can get honour in science but it does not pay. I begin to doubt if I have done wisely in giving vent to the cherished tendency towards science which has haunted me ever since my childhood." Then in 1853 he was encouraged to take a hopeful view. He writes: "I have become almost unable to exist without active intellectual excitement. I know that in this I find peace and rest such as I can attain in no other way. . . My course in life is taken. I *will* make myself a name and a position as well as an income by some kind of pursuit connected with science, which is the thing for which Nature has fitted me if she ever has fitted any one for anything" "London," he declares, "is *the* place—the centre of the world."

At last, at the end of 1854, relief came His dear friend Edward Forbes was appointed to the chair of natural history in Edinburgh, vacated by the death of Prof. Jamieson, and thereupon Huxley succeeded Forbes at Jermyn Street as naturalist to the Geological Survey and professor of natural history in the Government School of Mines, with an income which very soon was raised to 800*l.* a year. In July 1855 he was married to Miss Heathorn, who arrived from Australia with her parents. They had been engaged for eight years, and he had not seen her during the last five. Now at last he was able to settle down securely in London and to plan the future work of the busy life which lay before him. Heavy as were the tasks in lecturing, writing, in pure scientific investigation, and in advocacy of scientific doctrine which he gladly undertook, his life henceforth was a very happy one. Though from time to time he felt the strain of over-work, he could always recover his full strength by a tramp among the mountains of Wales or of Switzerland with the companionship of Tyndall, Hooker, or Lubbock. He had the immense satisfaction of knowing that he had chosen the right path, that his great natural gifts were exercised to the full, and were not only widely recognised and respected but were also effective in promoting the cause which he had at heart. It was in 1860 that, owing to his encounter with Wilberforce, Bishop of Oxford, at the meeting of the British Association, he became known to the wider public as a fearless exponent of Darwin's theory. From this time onwards he added to the task of his regular professional teaching that of expounding in addresses and review-articles—which (at the first) he termed "lay-sermons"—the scientific and philosophical doctrines which in his judgment could be effectively so treated.

It is well to emphasise here, in conclusion, that the high value and influence of Huxley's more technical contributions to the science known as animal morphology are universally recognised. They are collected and reproduced in full in the four memorial volumes in the editing of which I was joined by Sir Michael Foster They occupy about 2400 pages (royal octavo) and more than one hundred lithographic plates, many of quarto size. They show, as we stated in the preface to those volumes, that quite beyond and apart from the influence exerted by his popular writings, the progress of biology during the latter half of the nineteenth century was largely due to labours of his of which the general public knew nothing: and that he was in some respects the most original and the most fertile in discovery of all his fellow-workers in the same branch of science

Were I to give an adequate account of my personal impressions of Huxley, this article would become a lengthy autobiography. Suffice it to say that from the time (1860) when I, then a schoolboy took to him the chief treasure of my collection of fossils, namely, a mammalian jaw-bone from the Stonesfield slate which he himself laboriously developed from its matrix and intended to describe, I was fascinated by him and became his devoted disciple. I attended all his evening lectures and addresses, and followed with keenest pleasure his controversies On his way home from Egypt in 1871 he came to Naples, where I had been established for some months studying the embryology of the Mollusca and the rich fauna of the bay, whilst my friend Dohrn was negotiating the foundation of the Zoological Station. Huxley, to my great delight, stayed some days at Naples, and I acted as his guide to the top of Vesuvius, to Pompeii and to the Phlegrean fields. Later I demonstrated for him in his first summer course in temporary quarters at South Kensington, and in the following year in his new laboratory in the College of Science I was by his side when, without notes or printed paper, he delivered at the Belfast meeting of the British Association his address, lasting an hour and a half, on Descartes' theory that animals are automata. It was a wonderful effort and free from all hesitation or dislocation of words.

Others, no doubt, will be occupied at this moment in recalling the titles and significance of Huxley's published work. I must not venture on that congenial task. But I here submit two brief statements of an autobiographic character written by Huxley. The first was written in 1856 in his private journal on the night

when his son Noel was born—the son whom he lost four years later. It will be seen that the aspirations and intentions there expressed are not falsified by the retrospect embodied in the second extract, taken from his chapter of autobiography written some forty years later. They justify the motto adopted by him, "Tenax propositi"

From Huxley's private journal, written in 1856.

"In 1860 I may fairly look forward to 15 or 20 years' 'Meisterjahre,' and with the comprehensive views my training will have given me, I think it will be possible in that time to give a new and healthier direction to all Biological Science; to smite all humbugs, however big; to give a nobler tone to science; to set an example of abstinence from petty personal controversies and of toleration for everything but lying; to be indifferent as to whether work is recognised as mine or not, so long as it is done"

From a chapter entitled "Autobiography" written by Huxley in 1893 and published in the volume of essays called "Methods and Results," pp. 16 and 17.

"Men are said to be partial judges of themselves. Young men may be; I doubt if old men are Life seems terribly foreshortened as they look back, and the mountain they set themselves to climb in youth turns out to be a mere spur of immeasurably higher ranges when, with failing breath, they reach the top. But if I may speak of the objects I have had more or less definitely in view since I began the ascent of my hillock, they are briefly these: To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.

"It is with this intent that I have subordinated any reasonable, or unreasonable, ambition for scientific fame which I may have permitted myself to entertain to other ends; to the popularisation of science; to the development and organisation of scientific education; to the endless series of battles and skirmishes over evolution, and to untiring opposition to that ecclesiastical spirit, that clericalism, which in England, as everywhere else, and to whatever denomination it may belong, is the deadly enemy of science"

Thomas Henry Huxley.[1]

By Prof. E. B. Poulton, F.R.S.

WHEN I was invited to deliver the Huxley Lecture, and I need not say how great a distinction I felt the invitation to be, I thought how much better it would have been if the address could be delivered by one with much longer and more intimate associations with the great man whose memory we have met to honour My mind at once turned to my friend Sir Ray Lankester, who, when Huxley died, could look back over nearly forty years and write: "There has been no man or woman whom I have met on my journey through life, whom I have loved and regarded as I have him, and I feel that the world has shrunk and become a poor thing, now that his splendid spirit and delightful presence are gone from it Ever since I was a little boy he has been my ideal and hero" I would that he could be here to tell us of his abiding memories; but as this cannot be, he has most kindly yielded to the wish of an old friend and has sent a message:—

"I believe that no one of Huxley's scientific friends now living knew him so well or watched him with so keen an affection as I did, and I feel that the centenary of his birth is not so much an occasion for dwelling on his scientific work as of thinking and speaking of his personal characteristics and testifying to his living quality and charm.

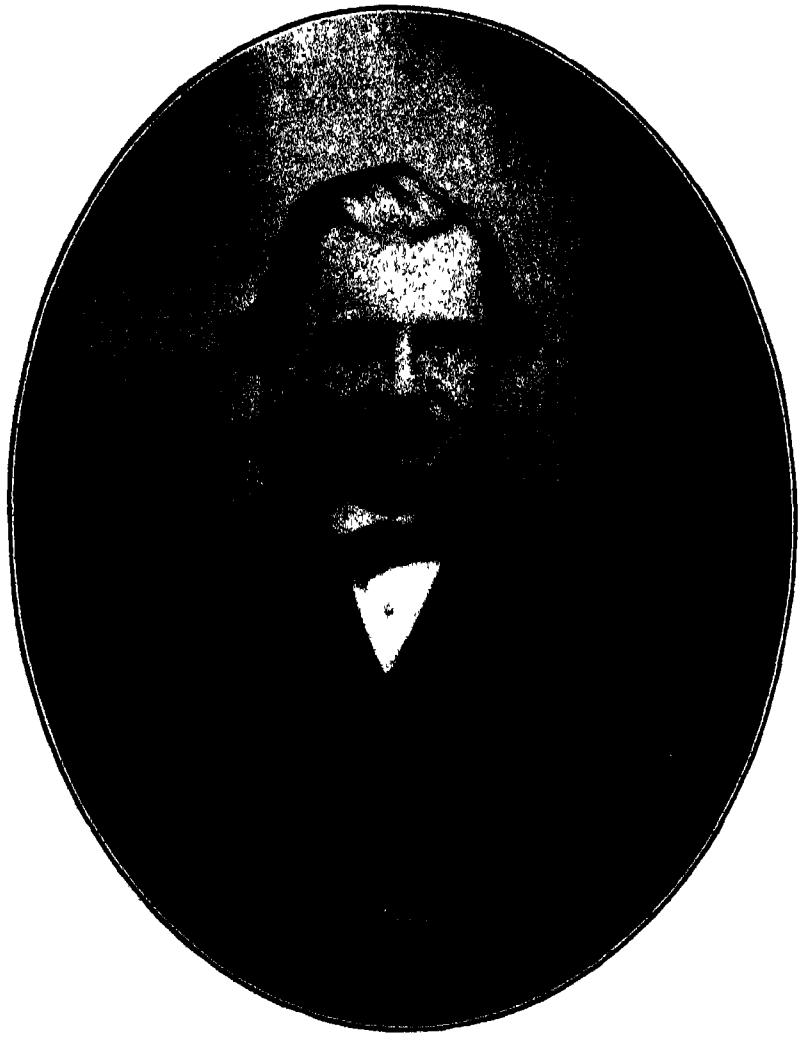
"Our main duty towards those who have never seen him, the youth of this day—cut off from traditional knowledge by the slaughter and disorganisation of the Great War—is to urge them to make up for their loss by their own effort, to read and discuss Huxley's writings for themselves, not only his published researches but also the delightful essays, full of wit and wisdom and an actual gospel of freedom for thought and loyalty to truth. Then, too, we have the record of his strenuous life preserved for ever in his vivid letters—his heroic adhesion to a career in science when fate seemed to forbid—his success after long years of disappointment—his friendships with Edward Forbes, Hooker, Henfrey, Tyndall and Darwin. These men were also my father's friends, and, as a boy, from 1859 onwards, I became Huxley's devoted admirer and disciple, attending all his lectures in my own time out of school, following his contests with Owen and other opponents of Darwin, and encouraged by his help and personal kindness to share, however humbly, in the almost daily excitement of his zoological discoveries and his brilliant encounters with doughty knights of the pen."

The thoughts which Sir Ray Lankester has expressed with much greater authority were also my own—that to-day we should try to recall a great personality, the man himself, his powers and their growth, his attitude towards life, finding in the attempt that the heights he attained were only reached by resolute effort and

[1] From the Centenary Lecture delivered at the Royal College of Science (Imperial College of Science and Technology), South Kensington, on May 4.

undaunted determination. Thus Huxley will become to the young student, not some far-off impossible ideal, but a great example and encouragement.

Huxley was the youngest of the five men who, more than all others, gave life to the ancient conception of evolution, and made possible the chief intellectual inspiration of the modern world. Wallace was two years older, Spencer five, Hooker eight, and Darwin sixteen. He tells us in his brief autobiography that he inherited from his father the faculty for drawing, a hot temper, and "that amount of tenacity of purpose which unfriendly observers sometimes call obstinacy", from his mother rapidity of thought. The high development of this last quality was referred to by Darwin in his own autobiography: "I have no great quickness of apprehension or wit which is so remarkable in some clever men, for instance, Huxley." A keen sense of humour was invaluable in his varied dealings with men. Think of his words of caution to one who sought a post in which there would be numberless "little vanities and rivalries to smooth over and conciliate," a post which, of necessity, required the utmost forbearance: "Now you do *not* 'suffer fools gladly'; on the contrary, you 'gladly make fools suffer.'" The humour here emphasises but at the same time softens the advice and renders it acceptable.



From a wet-plate photograph taken about the year 1877 at Kimmerghame, by Mr. A. A. Campbell Swinton, F.R.S.

Huxley described himself as "almost a fanatic for the sanctity of truth." Referring to some adverse opinion, he wrote to his wife that he did not know what was meant by "the disputed reputation" unless it was "a reputation for getting into disputes," continuing: "To say truth I am not greatly concerned about any reputation except that of being entirely honest and straightforward, and that reputation I think and hope I have."

He once said that it was only when trying to comfort a friend in trouble that he was sometimes tempted to deviate from the strict truth. His deeply sympathetic nature is also revealed in words spoken to his son in 1895, a few months before he died: "It is one of the most saddening things in life that, try as we may, we can never be certain of making people happy, whereas we can almost always be certain of making them unhappy."

Huxley's differences with his friends — sometimes sharp differences in opinions conscientiously held, where there could be no yielding on either side — brought no bitterness and no estrangement. The issue was treated with the utmost candour, and, with regard to it, there was the fullest recognition of divergence, but at the same time there existed on both sides a fixed determination that the difference should never be permitted to spread beyond the issue and weaken any of the innumerable ties by which friend is bound to friend. To read his correspondence with those from whom he differed is an education in the preservation of friendship.

Huxley, like Darwin and Hooker, owed much to the years with the Navy, when he was thrown upon his own resources in attempting to solve the exciting zoological problems which were always confronting him. How fully he acknowledged the value of this experience is revealed in a letter to Hooker on November 15, 1888, when he received the Copley Medal of the Royal Society the year after it had been awarded to his friend:

"Who ever heard of two biologers getting it one after another? . . It is getting on for forty years since we were first 'acquent,' and considering with what a very considerable dose of tenacity, vivacity, and that glorious firmness (which the beasts who don't like us call obstinacy) we are both endowed, the fact that we have never had the shadow of a shade of a quarrel is more to our credit than being ex-Presidents and Copley medallists.

"But we have had a masonic bond in both being well salted in early life. I have always felt I owed a great deal to my acquaintance with the realities of things gained [in] the old *Rattlesnake*."

It must be remembered, however, that he suffered a good deal of disappointment in the quiet contempt for scientific pursuits shown by the officers, and in the long periods which passed before he received any intelligence of the papers on his researches which he had sent home.

Far greater trials awaited him when he returned to England in 1850, and entered upon four solitary years of despondency and vain attempts to obtain a position which would enable him to marry without giving up the work he loved best. A few weeks after his return he wrote to his favourite sister, who had settled in America, telling her of his parting with his future wife, to whom he had become engaged at Sydney in 1847. A few words reveal the solitude he endured: "You know I love but few—in the real meaning of the word, perhaps, but two—she and you. And now she is away and you are away."

An even greater trial was the insistent doubt whether he was doing right in continuing an engagement with so poor a prospect of marriage, and whether he ought not to enter a profession and in so doing starve what he knew to be the best that was in him. Then there was the barrier of distance, a letter requiring three or four, sometimes even six months, to reach Sydney; but in spite of all the difficulties, it was the correspondence with his future wife and his sister which finally confirmed him in the determination to keep to the work which called forth his highest powers.

He became an F.R.S. in 1851, when he was twenty-six. There were thirty-eight candidates, and the number of elections was fifteen, as at the present day. In the following year he was awarded the Royal Medal, but his pleasure at this recognition could not last long in a time of deep disappointment and bitterness.

"The honours of men I value so far as they are evidences of power," he wrote a few days after the award was made known, "but with the cynical mistrust of their judgment and my own worthiness, which always haunts me, I put very little faith in them. Their praise makes me sneer inwardly. God forgive me if I do them any great wrong."

The fierce and bitter rivalries of that time were a further trial, from which we have been happily freed by an ever-increasing specialism which leads the scientific worker to seek help from another and give help to him rather than attempt to enter a strange land.

Huxley was, at this period of his life, an unsuccessful candidate for biological chairs at Toronto, Aberdeen, Cork, and King's College, London. While still hoping that he might obtain the last of these he wrote to his sister, in April 1853, words which reveal the despair that was coming over him:

"In truth I am often very weary. The longer one lives the more the ideal and the purpose vanishes out of one's life, and I begin to doubt whether I have done wisely in giving vent to the cherished tendency towards Science which has haunted me ever since my childhood. . . . I think it is very likely that if this King's College business goes against me, I may give up the farce altogether. . . ."

Later in the same year a letter from Sydney brought him comfort. "I wish to Heaven it had reached me six months ago," he wrote, "it would have saved me a world of pain and error." Thus strengthened he kept firm and did not again lose heart, until at length, in July 1854, the tide turned and he was appointed to two lectureships at the School of Mines, held by Edward Forbes, who had just been called to an Edinburgh chair. The double post was paid 200*l*. a year, and yet such was the encouragement given to science in those days that he wrote on July 30: "I am chief of my own department, and my position is considered a very good one—as good as anything of its kind in London." However, he had not long to wait before other work was offered to him, so that he was able to marry in the following year.

Huxley is well known to have been one of our finest and most powerful speakers, but he gained this success by determination and by practice. I have heard Prof. Rolleston refer to Huxley as a great example of the results which may be achieved by one who is not fluent by nature. A young man who realises the value of the weapon but doubts his own capacity and nerve may well take courage when he hears Huxley's account of his own feelings as he began his first lecture at the Royal Institution in April 1852: "I can now quite understand what it is to be going to be hanged, and

nothing but the necessity of the case prevented me from running away."

What he became is well shown by the words of a would-be critic who attempted to make out that Huxley was no great speaker: "All he did was to set some interesting theory unadorned before his audience, when such success as he attained was due to the compelling nature of the subject itself." This surely was the highest compliment that could be paid to a man as a speaker—that he thought of his subject rather than of himself, and it is here that natural fluency becomes so great a danger, a temptation to the speaker to attitudinise upon his subject rather than to display it, to forget that its "compelling nature" can only be revealed by serious effort in searching analysis and clear description.

Public speaking remained an effort to the end of his life Just as the company was about to enter the dining-hall for the Anniversary dinner of the Royal Society in 1892, I happened to hear Sir Michael Foster ask Huxley to help the officers out of a difficulty by proposing the toast of the medallists, in the sudden and unavoidable absence of the speaker named on the menu. He promised to fill the gap, but I am afraid that as a result he did not enjoy his dinner, for from time to time he sat with closed eyes, evidently thinking deeply about his speech. Nevertheless he began by making a trenchant reply to a previous speech, and, for his main theme, gave a brief but finished account of the history of the medals and the work of the medallists, concluding with a charming defence of the Society for the first two awards of the Darwin Medal, intended primarily for young men:

"It lay in the eternal fitness of things that Wallace and Hooker should receive the Darwin Medal; and that these old young-men should give it a heightened value for the young young-men to whom it would hereafter pass." But before this, its value was to be still further heightened, for the next award was to a third "old young-man," and Huxley's last public speech was a reply for the medallists when he received the Darwin Medal in 1894.

The clear and beautiful style of Huxley's writing was also an outcome of great effort. "I have a great love and respect for my native tongue," he wrote in 1891, "and take great pains to use it properly. Sometimes I write essays half-a-dozen times before I can get them into the proper shape . . ."; and, in 1887: "When I get to a certain point of tinkering my phrases I have to put them aside for a day or two."

Here, as with his public speaking, we may hope that his great example will encourage young men of science, leading them to practise severe self-criticism and never to be content with careless writing. There is reason to fear that such efforts are quite as necessary now as in 1894, when Huxley, referring to his speech at the twenty-fifth anniversary of NATURE, wrote: "I scolded the young fellows pretty sharply for their slovenly writing" In another respect we may hope that Huxley's example will be followed. It should never be forgotten that he found constant delight in the great writers of English; he was not only a great man of science, he "warmed both hands before the fire of life"

This is not the occasion for dwelling on Huxley's zoological or palæontological discoveries. Dr Chalmers Mitchell has told us that when he came to study the classical monograph on the Hydrozoa, he at first felt some disappointment It was all so familiar, rather like the Hamlet which, read for the first time, was found to be "so full of quotations" So also with the work upon birds and his anatomical researches generally as Dr. Mitchell well says, "Huxley's work was essentially living and stimulating, and too often it has become lost to sight simply because of the vast superstructures of new facts to which it gave rise" For this reason the late Mr G. H Verrall used to say that "the best monograph is the one soonest out-of-date"—a fruitful parent supplanted by its own offspring.

The *essential* duty of a university, as Huxley believed it to be, is set forth in a sentence, written in 1892:

"The modern world knows that the only source of real knowledge lies in the application of scientific methods of enquiry to the ascertainment of the facts of existence; that the ascertainable is infinitely greater than the ascertained, and that the chief business of the teacher is not so much to make scholars as to train pioneers"

It is interesting to observe how nearly the scientific and the literary judgments may agree I have heard the following opinion expressed with characteristic emphasis by the late Prof York Powell:

"Many people think that a university must consist of professors, tutors, lecturers, colleges, delegacies, committees and all kinds of administrative offices, but in reality only two things are *essential*—a library and a printing-press, and of course for science-men, laboratories and a museum"

In the introduction to the volumes of Huxley's collected scientific papers, the editors, Sir Michael Foster and Sir Ray Lankester, express the fear that his classical discoveries may be forgotten. At that time it seemed that his collected essays on more general subjects would always be widely read; but the great barrier of the War has intervened, and it is now, I am afraid, necessary to remind young men, as Sir Ray Lankester has done, of all that they will lose by the neglect of these volumes.

Much has been written during the past few weeks on

the need for popular reprints of books with sound views on economic subjects, and various works have been suggested as suitable for the purpose. So far as I am aware, no mention has been made of Huxley's essays on these questions, and yet how much misery would have been prevented if the wise advice he has given had been followed. No doubt can be thrown upon his love for the people and desire to better their condition. "If I am to be remembered at all," he wrote in 1880, "I would rather it should be as 'a man who did his best to help the people' than by any other title." He put his best work into the courses for working-men, and refused to consider the proposals to give them up when it was suggested that there were now many institutes and colleges open to such students. He still wished to give them something they could not get elsewhere, and working-men gratefully recognised the work that he did for them and loved him for it. If his words were made readily accessible, there is hope that they would find listeners among the men who would suffer most from the delusions and chimæras which some among them appear to find so attractive. Here are his conclusions to the discussion of certain important economic questions of his day and ours:

"Assuredly, if I believed that any of the schemes hitherto proposed for bringing about social amelioration were likely to attain their end, I should think what remains to me of life well spent in furthering it. But my interest in these questions did not begin the day before yesterday, and, whether right or wrong, it is no hasty conclusion of mine that we have small chance of doing rightly in this matter (or indeed in any other) unless we think rightly. Further, that we shall never think rightly in politics until we have cleared our minds of delusions, and more especially of the philosophical delusions which, as I have endeavoured to show, have infested political thought for centuries."

". . . Seeing how great and manifold are the inevitable sufferings of men, how profoundly important it is that all should give their best will and devote their best intelligence to the alleviation of those sufferings which can be diminished, by seeking out, and, as far as lies within human power, removing their causes, it is surely lamentable that they should be drawn away by speculative chimæras from the attempt to find that narrow path which for nations, as for individual men, is the sole road to permanent well-being."

The great event of Huxley's career was his defence of Darwin, leading on to something much wider and deeper, the defence of freedom for thought. A large part of the volumes of essays is concerned directly or indirectly with this subject. The necessity for defence, both special and general, was amusingly explained by him in his last public utterance when he returned thanks for the Royal Society medallists on November 30, 1894. He said that, when the award of the Darwin Medal was announced, "the ingrained instincts of an old official" led him at once to consider "how can my Government be justified?" He had no such claims, he said, as his two predecessors, and had begun to despair of providing an answer to the critics of the Royal Society, when there occurred to him "that famous and comfortable line . . . 'They also serve who only stand and wait.'"

"I am bound to confess," to continue in his own words, "that the standing and waiting, so far as I am concerned, . . has been of a somewhat peculiar character. I can only explain it, if you will permit me to narrate a story which came to me in my old nautical days, and which, I believe, has just as much foundation as a good deal of other information which I derived at the same period from the same source. There was a merchant ship in which a member of the Society of Friends had taken passage, and that ship was attacked by a pirate, and the captain thereupon put into the hands of the member of the Society of Friends a pike, and desired him to take part in the subsequent action, to which, as you may imagine, the reply was that he would do nothing of the kind, but he said that he had no objection to stand and wait at the gangway. He did stand and wait with the pike in his hands, and when the pirates mounted and showed themselves coming on board he thrust his pike with the sharp end forward into the persons who were mounting, and he said, 'Friend, keep on board thine own ship.' It is in that sense that I venture to interpret the principle of standing and waiting to which I referred. I was convinced as firmly as I have ever been convinced of anything in my life, that the *Origin of Species* was a ship laden with a cargo of rich value, and which, if she were permitted to pursue her course, would reach a veritable scientific Golconda, and I thought it my duty, however naturally averse I might be to fighting, to bid those who would disturb her beneficent operations to keep on board their own ship."

Out of this struggle came the recognition of the fact that something much more important than Darwinism had been challenged, nothing less indeed than the validity of scientific thought. "The welfare of mankind," Sir Michael Foster has said, "was, in his eyes, indissolubly bound up with the advance, the steady, nay, the rapid advance of natural knowledge. Any hindrance to that advance was, to his mind, a wrong to mankind. What hindrance could be more hurtful than the contention that natural knowledge was not master of its own domain, but must bow its head and keep silence when even in its own field it came into conflict with the master of another land? The call to strive for the doing away of that hindrance rang loud in Huxley's ears." His answer to that call has had the great result that "scientific ways of thinking, which are even more important than scientific discoveries," may, at least in this country, be followed peacefully, while those who might have been inclined to raise a barrier are now wise enough to "keep on board their own ship."

Plant Biology in the 'Seventies.

By Sir W. T. Thiselton-Dyer, K.C.M.G., C.I.E

THE Editor's request for some account of my relation with Huxley "in the organisation of the teaching of botany at South Kensington" and for reminiscences of him requires some autobiography to explain how it arose.

I was London-bred and educated in London day schools. My parents lived in Berkeley Street, where my father practised as a physician. A noisy rookery woke me in the morning to see the sun on the Crystal Palace and Buckingham Palace in mist. St. Peter's in Eaton Square was my first school, a classical temple long since demolished, balancing the church at the other end; it had produced a senior wrangler, who was exhibited on Speech Day, and Sir Charles Dilke was a school-fellow. I passed on to King's College School in the classical side.

Summer holidays were spent at Bury Street near Edmonton, at the house of my maternal grandfather, Thomas Firminger, LL.D., who had been "sole assistant Astronomer" with Dr Maskelyne at Greenwich (1799–1808). I remember his telling me that, narrowly escaping being run over in Fleet Street, his only anxiety at the moment was the lunar observation that night. There was a scientific atmosphere at Bury Street; boyish curiosity was stimulated by various pieces of apparatus the purpose of which was only gradually revealed. There was a primitive electrical machine which we induced my grandfather to put into action with striking results. The culminating excitement was an occultation of Jupiter watched through a large telescope. I got further nutriment from Joyce's scientific dialogues.

My mother was a keen field botanist; during the holidays she initiated me in the Linnæan system and the determination of the plants we collected—she insisted on securing radical leaves!—in Sir William Hooker's "British Flora." I still possess the well-thumbed volume. Later, at school, I ran up against a school-fellow with a vasculum. I said, "You are a botanist?" he replied, "I am," and then and there we swore eternal friendship. This was Henry Trimen, who died director of the Peradeniya Botanic Garden.

We soon agreed that mere collecting was not a sufficient end in itself, and while still schoolboys we commenced a botanical survey of Middlesex; it was published in 1869. We did not think at the time that we should take part later in a larger survey of the Empire. Our smaller enterprise afforded more than one illustration of the scientific outcome of such work. The Thames is the southern boundary of the county; we found on its east side that there were estuarine plants brought by the tide, while on the west were calciphilous plants brought by winter floods.

I found a never-failing resource on half-holidays, when botanical field-work was out of season, in the Geological Museum which was near at hand in Jermyn Street. I doubt if anything of its contents escaped me, from the vast geological map on the ground floor to the solar system on the topmost gallery. But a deeper attraction was the evening lectures to working men delivered by the professors of the School of Mines. Perhaps my frequenting the museum allowed me admission without challenge.

It must have been in his memorable course in 1862 that I first saw Huxley. His 1857 portrait recalls to me his alert expression, the twinkle of the eye, firm mouth, and that general aspect which he called Iberian. His choice of words was always apt, and their delivery pleasant to the ear. The lectures themselves were carefully prepared; they were, fortunately, published, and remain a classic. As is well known, Huxley had to rely in Jermyn Street on oral teaching alone, with seldom anything to support it but what Flower described as "his great facility for bold and dashing sketching." I can recall only one detail of actual demonstration. A plate appeared on the lecture table with an oyster and a knife. Having explained that the oyster was kept closed by muscular action, he remarked, "If the cook is a person of any judgment at all, she will insert the knife here." He did so, and the valves fell apart. The quizzical expression and its rhythm I knew afterwards to be authentic Huxley.

It was in these lectures that Huxley, with his invariable honesty, told the working men that though the Darwinian hypothesis held the field, "its logical foundation was insecure," and he never shook himself from this position. He came to look upon the defect as of no importance in view of the impregnable basis supplied by palæontology to evolution.

The following year I went to Oxford and studied mathematics with Henry Smith and chemistry with Brodie. I took my degree with honours in both. When my father died in 1868, the Berkeley Street home was broken up. I had to find a livelihood; teaching seemed the only choice and botany my vocation. It had been decided at Oxford that when there was a vacancy in the dormant chair I would be appointed. This had occurred in 1867; but the technical disqualification of not having reached M.A. standing ruled me out, and the chair went to my friend Lawson, a Cambridge man.

In 1870 I was appointed professor of botany in the Royal College of Science for Ireland, Dublin, under the Science and Art Department. The emolument was little more than nominal, but the teacher was fortunate in being unfettered by any curriculum. According to the late Prof. Bayley Balfour, "the study of Botany as a science has been dependent on Medicine, and its aim to give the practitioner a correct knowledge of the plants which were the source of drugs" So limited, it was a compulsory part of medical training with its sequel materia medica. Huxley thought that this had become a mischievous encumbrance to study constantly more exacting; the practitioner would use drugs, but their manufacture no more concerned him than the metallurgy of his instruments a surgeon.

The ninth edition of the "Encyclopædia Britannica" contains *the* article on botany by the elder Balfour; it may be not unfairly regarded as representing the current view of the scope and limits of botanical science in 1876. It covers more than eighty pages in double columns, but does not profess to treat more than the "Structure and Morphology of Plants," that is, little more than flowering plants. It may seem paradoxical, but in any wide sense it does not treat of botany at all. Balfour simply tumbled into the Encyclopædia his class text-book for Edinburgh medical students; it is, in fact, no more than an illustrated enumeration of the terms devised by Linnæus for descriptive botany. These, especially when clothed in Latin, are in cosmopolitan use. When exhaustively applied to a particular plant it is said that a competent artist could build up its portrait without seeing it. It is difficult to imagine anything more uninspiring than a terminological diet Balfour made it tolerable by a system of excursions, which invested it with some reality. The greater part of Scotland was traversed; students were introduced to what is now known as "ecology." Balfour could and did look at plants in relation to the conditions of growth; his students got to "know their plants," which Sir Joseph Hooker thought the great desideratum.

In 1871 I planned and delivered a course in Dublin covering the whole vegetable kingdom; it was a new departure in botanical teaching. But, as with Huxley in Jermyn Street, I had no laboratory or even a private room to myself. No practical work by the students or even demonstrations to them were possible.

My duties in Dublin only occupied the first half of the year and afterwards left me free. I returned to London at the end of July (1871) and reported myself to Capt. Donnelly, the Inspector for science at South Kensington. He introduced me to Huxley, who had organised in temporary accommodation a six weeks' course for teachers, in which he had Michael Foster, Lankester, and Rutherford as assistants. I spent a day in watching the proceedings. Such courses for teachers were vacation work independent of the systematic teaching covering the animal kingdom for ordinary students, which Huxley continued on the same lines as in Jermyn Street; but there was the all-important difference that he was now able to supplement oral teaching by practical dissection and demonstration. In the following year he inaugurated his new laboratories with a summer class, in which the now well-known course of "Elementary Biology" was given for the first time, with the same demonstrators, "assisted by H. N. Martin." It is not to be wondered at that the double-tide of lecturing and the strain of organisation in the transfer to South Kensington left Huxley "very shaky in health." It had been arranged, therefore, that he should have a holiday abroad, and that in 1873 "I should take his place and lecture on botany" with "the application of the same system to botanical teaching."

Huxley's first love had been botany; it was the subject of his first prize. He attended Lindley's lectures at the Chelsea Botanic Gardens and won another, a gold medal, in a competition from the Society of Apothecaries. He got no comfort from Schleiden's "Principles of Scientific Botany" (1847) (nor did I), but explored with better results the *Annales des sciences naturelles* at the British Museum. Later, we both drank at the same spring.

I drew my own inspiration from the fourth edition of William Carpenter's "Principles of Comparative Physiology" (1854). This contained incidentally the only accounts in English for the next quarter of a century of the most striking advances in our knowledge of the life-histories of plants. Carpenter, as he told me, saw Count Lesczyc-Suminski when he brought to London the fern-prothallus (1848) which the Ray Society scouted. It had been better advised when it published in 1862 a translation of Hofmeister's "Higher Cryptogamia" (1851). Of this immortal work Sachs says: "When Darwin's theory was given to the world eight years after, the relations of affinity between the great divisions of the vegetable kingdom were so well established and so patent, that the theory of descent had only to accept what genetic morphology had actually brought to view."

Huxley wrote of Carpenter with affection: "I was a very young man, almost friendless in the scientific world, when I returned to England in 1850. I made Carpenter's acquaintance in 1851, and was able to give him some information which he found useful for a new edition (the fourth) of the 'Principles of Comparative Physiology.' From that time he remained a friend who did me many a good turn."

I had accepted Sir Joseph Hooker's invitation to assist him by sub-editing his "Flora of British India." Teaching at South Kensington continued temporarily my attachment to the Science and Art Department, but was scarcely compatible with work for it in Dublin, which I therefore gave up in 1872.

About this time the ninth edition of the "Encyclopædia Britannica" was started under the editorship of Prof. Baynes. Huxley and Clerk Maxwell were helping him "in attempting to cover the ground of modern science." Huxley had made good progress in getting the animal kingdom well in hand, and was keen to get the vegetable kingdom treated on similar lines, but . . .! Towards the end of the year I received a letter from him inviting me to meet Baynes at his house, but he could only make an appointment for 11 o'clock on a wintry night. Huxley opened the door himself, led the way to his study, and put on a kettle to boil. I was introduced to Baynes, who at once started a discussion of "free will." Huxley would not have it. He told Baynes that if we could project ourselves back into the cosmic vapour and then look forward we would be seen drinking our gin and water. Baynes said no more. As to the vegetable kingdom, Huxley got no comfort. Nothing could be done until the incubus of Balfour's preposterous article was got rid of, and it appeared that a binding contract with the publishers made this impossible. No more could be arranged than that I was to join Huxley in writing the preliminary article on biology. This was done, and published in 1875. In 1902 the tenth edition gave the vegetable kingdom a worthier treatment. Under Dr. Scott as botanical editor, it was illustrated and illuminated by a series of articles more up-to-date for the most part than anything accessible at the time

The 1873 course commenced on June 24 and lasted for six weeks. The lectures presented no difficulty, as the ground had already been gone over in Dublin. The plan was that adopted by Huxley: a lecture at 10 o'clock and then an adjournment to the laboratory, where each student was provided with a place, microscope, and necessary instrumental appliances. The work continued from 11 to 1 P.M. and from 2 till 4. It was expected that, with the assistance of the lecturer and his assistants, the students would then have succeeded in verifying every material statement made in the lecture.

I was confronted with the difficulty that we had no tradition to follow or previous experience to guide us. The whole business was one of sheer adventure. I secured the help of Prof. Lawson from Oxford, and also took over Jeffrey Parker, Huxley's assistant. Lawson and I took lodgings together at Gunnersbury, so as to be within easy reach of Kew. For an account of how we worked and with what measure of success I must make use of a letter which I wrote to Prof. Reynolds Green while the details were fresh in my memory. It was not published until after his death in 1914.

"The difficulties we had to encounter were enormous. The first was to keep up a continuous supply of material; but we had Kew to draw upon, and a great number of helpful friends. Archer in Dublin sent us fresh-water Algæ (including *Closterium*, with its internal display of Brownian motion); a banker at Margate, marine Algæ; Ransome of Nottingham and De Bary (through Lankester), *Æthalium*; H. C. Watson, *Plularia*, etc. The worst difficulty was to make sure of our own ground; Lawson and I were generally up half the night rehearsing the demonstration for the following day. However, we soon worked the class up to a pitch of enthusiasm, and this helped enormously. I was perfectly frank in explaining our own inexperience and enlisting its help. The more expert men often had good luck in 'getting things out.' The upshot was that we succeeded in showing shoals of things that had never been seen in England before. News of what was going on soon got about, and though we were flattered, we were a good deal bothered by visitors. No one had ever seen in this country an active plasmodium of a Myxomycete, and Klein asked to be telegraphed for when it began to work. W Kitchen Parker spent most of his time in the laboratory. Sir Edward Poynter came to see vegetable spermatozoids, and we gratified him with those of *Chara* under a one-twelfth immersion objective. Gymnosperms gave us most trouble. I was very keen to demonstrate what Hofmeister had done, and to trace the outcome and fate of the megaspore from the Fern upwards. It would have seemed hopeless if Casimir de Candolle had not come to England after working with Strasburger, and brought a number of preparations with him. He showed me that the difficulties were not insuperable. This was before the days of microtomes, or even embedding. . . . However, the ground of the new teaching was broken once for all."

I was fairly brain-tired at the end. But three weeks with the 1st Oxfordshire Light Infantry—the University Corps—at the Dartmoor manœuvres remedied that. The occasion was memorable, as this was the first time that volunteers had been brigaded with regular troops. I went back to the ranks, and I am afraid my energetic sergeant, now the venerable Provost of Queen's College, found me rather slack.

Huxley and Donnelly were more than satisfied with our experiment; the former asked me to take charge of the practical work of his biology class in the following year. It had a surprise visit from the President of the Council (the Duke of Richmond) and the Education Minister (Lord Sandon).

In 1875 I was asked to repeat my own course in a more leisurely eight weeks, with Vines as demonstrator. I gave it again the following year, when I willingly

complied with Donnelly's wish that women teachers should be included, and for the first time.

In 1875 Disraeli, with whom I never had any acquaintance or communication, appointed me assistant director of Kew. I should have preferred staying at South Kensington if any hope of a permanent appointment could have been held out But this appeared to be impossible. However, I was asked (and permitted) to give a final course in 1880, consisting only of the lectures.

Having put my hand to the Kew plough, I felt in honour bound not to draw back. But this disposed of my teaching ambition. If my friend Prof. Oliver is right in giving me credit for establishing the "New Botany," it was the co-operation and sympathy of Huxley that made it possible, and that is a memory to be proud of.

I think I may claim that my 1871 Dublin syllabus was the first rough sketch. I will quote the first sentence:

"Botany, the study of Plants; correlative to Zoology, the study of Animals. The two conjointly form Biology, the study of Living things."

In 1875 Huxley wrote in the preface of his "Practical Instruction in Elementary Biology":

"Twenty years ago, I arrived at the conviction that the study of living bodies is really one discipline, which is divided into Zoology and Botany simply as a matter of convenience."

Twenty years before finds Huxley in touch with William Carpenter and the "Principles of Comparative Physiology" This was the germ which eventually fructified in the laboratories at South Kensington inaugurated in 1872

And in Dublin half a century later (1922) Dr. Dixon, the University professor, has presented his students with what I can only describe as a consummate and beautiful picture of detailed "Practical Plant Biology"

Teaching of Biological Science.

By Prof. F. O. Bower, F.R.S

THE influence of Prof. Huxley has moulded education in many ways. Others will tell of his activities as a zoologist, as an administrator, and member of many Royal Commissions; and as an essayist and writer of text-books that profoundly affected the schools at the time when scientific subjects were first entering into competition with the strict discipline of the classics. But now, half a century after the event, it may not be so readily remembered that it is to Huxley's initiative that the current method of laboratory teaching of the biological sciences in universities and colleges is mainly due.

Up to the middle of the nineteenth century authoritative statement by the teacher, rather than personal observation, was the source of knowledge for the ordinary student of the biological sciences. It is true that occasional microscopic demonstration had been early initiated in Edinburgh by the elder Balfour. We read also of Hofmeister guiding the laboratory work of a band of enthusiasts in Tübingen; and elsewhere no doubt sporadic work was being done in biological laboratories But it is undoubtedly to Huxley that we owe the initiation of that systematic laboratory training which has now become general. He laid special stress upon personal observation at first-hand as the leading feature of biological study, even for elementary students. He did not abolish the lecture-room, but he linked it with the laboratory, so that the student, duly primed with a vivid description of what others had seen, passed to the laboratory to see, confirm, or criticise for himself. Those who have grown up under this newer method will with difficulty realise the revulsion thus brought about. Its effect was at a single stroke to convert each student into a potential investigator On the other hand, the new method would react inevitably upon the teacher, boomerang-fashion. Knowing that any or all of his students might form an independent estimate of the matter in hand, he must not only be accurate in fact, but also be ready for discussion. Every laboratory class became at once a potential board of examination of the demonstrating staff.

I had not the advantage of seeing for myself the first experimental trials of the new method. We may imagine what kind of courses they must have been under the direct management of Huxley himself, assisted by Burdon-Sanderson, Martin, Thiselton-Dyer, and Ray Lankester. The course for beginners was soon crystallised into the well-known volume on "Elementary Biology," by Huxley and Martin. Here a number of carefully selected plants and animals, starting from the simplest and progressing to more complex forms, were subjected to detailed structural analysis, together with some simple physiological experiments. The text described each step of preparation, and the results to be expected. Thus the method became stereotyped. Where the book fell into less expert hands, and its spirit filtered through

less potent minds, the results were naturally less satisfactory; but this fact does not discount the excellence of the method.

Very soon more detailed courses were devised respectively on animals and plants separately. Those on plants were conducted by Thiselton-Dyer, and I demonstrated to some of the earliest of these, with Vines, Marshall Ward, and Alexander MacNab as colleagues. The method was the same, and the courses were held in Huxley's laboratory. But he himself was only seen at intervals, and took no part in the botanical work. About this time Vines had tentatively spread the system to Cambridge, where a small band of enthusiasts gathered around him in a room lent for the purpose in the physiological department by Sir Michael Foster: among these I was one of the earliest adherents



From a photograph by H. Huxley, about 1881

Having this experience in hand of the practical working of the new method, the transition was not difficult from demonstrator to lecturer, and in 1882 I found myself appointed to conduct the regular courses in botany for teachers in training which were then initiated, in place of the occasional courses for selected school-teachers in the summer. The elementary course consisted of lectures and laboratory work, for which I was personally responsible. Up to this time I had only seen Huxley occasionally, and never at near hand. I was still inclined to visualise him as he appeared in photographs of the period of the Oxford Meeting of the British Association: as the protagonist of Darwinism, with aspect as incisive as his speech, and arrayed in the dress of the period. In coming into close official relation with Huxley I found him to be a man of medium height, with a well-knit figure, rather greyish in complexion, clean-shaved, but with side-whiskers, and plentiful grey hair, worn rather long, and brushed sharply back from a face that bore an eager and vivid but kindly expression. His well-cut fashionable clothes can scarcely have come from any other source than Savile Row. These, together with spats and neat boots, all conveyed the impression of a man of the world rather than the pundit.

Certain characteristic incidents during these years under Huxley remain engraven on my memory, and each conveys its own sidelight on his activities and methods. That most deeply impressed was on the occasion of my first lecture, naturally a moment of trepidation for a beginner. The day before this event was due, a message came to me: "The Dean presents his compliments, and will you have any objection to his attending your first lecture?" I replied, perhaps straining the strict truth, that I should be happy to see him. He entered the lecture-room with me, conversing pleasantly. But he sat himself in the middle of the front row, stretched out his legs, buried his chin in his waistcoat, and snorted at intervals. At the close of the lecture he said cryptically that he had been interested, and that I had told him various things he had never heard before. Then came the reward for this trying ordeal, for he said: "There is one thing I should like to tell you as a young lecturer: lecture your audience, do not lecture your blackboard." He went up to the black-board, took a piece of chalk and began to draw, then looking over his right shoulder he said "Cultivate this attitude" I have never forgotten that advice, and have passed it on to many other beginners. But why do not all seniors help their junior staff by similar kindly advice?

This whole incident showed a virile but genial method in handling a junior. He left it open to me to say "No" But being present he laid himself out to be helpful. So far as I remember, he never again entered my lecture-room or laboratory while work was going on He had sampled the methods of his junior, and then left him to work them out in his own way. Doubtless, however, he had his own means of judging whether the work was going on satisfactorily.

Another incident was the sitting of a committee, called together by General Donnelly, to devise a scheme for exhibits at the Bethnal Green Museum, illustrative of natural products of use to man. Huxley was the chief figure, but with him were Chandler Roberts-Austen, Guthrie, Judd, Church, and others. After general principles had been laid down, Huxley told us that he intended to take the pig, and to show by

exhibits in museum cases how every part of its body is made useful: bristles for brushes, the hide for saddle-covers and book-binding, as well as the rest for human food. He then suddenly turned to me and asked: "What will you do for the Vegetable Kingdom?" I replied I would undertake an exhibit of the Cruciferæ. Unfortunately, so far as I am aware, the scheme was never pursued; but it illustrated Huxley's desire to make the science of ordinary life real to the general public.

In 1883 Huxley was appointed president of the Royal Society, and I thought it my duty to offer congratulations to my chief. Rather shyly I made my little speech, but was rather taken aback by the rejoinder: "You might as well congratulate a man on carrying two hundredweights on his shoulders." Clearly what impressed him was not so much the dignity of the supreme official position in science in Britain as the obligations which it laid upon him; and these, as we have good reason to believe, he carried out to the detriment of his health.

In 1884 the chair of botany at Oxford was vacant, and I asked Huxley's advice as to entering a candidature for it. He strongly urged that "Any young man who has confidence in himself should stay in London. It is the centre of scientific life, where he will hear of novelties as they arise." He then illustrated his thesis by a brief sketch of his own life, which I regret I did not write down at once. He told me of his difficult position after return from the expedition in H.M.S. *Rattlesnake*, of his ill-health, and his literary efforts as a young married man. He wound up with the phrase: "And I don't suppose there was a more unpromising couple in London than we were." Considering his final success, this illustration greatly strengthened his argument; but I entered a candidature, and failed before my senior, Sir Isaac Balfour. Here again we see Huxley's sympathetic treatment of a younger man. But his general thesis may be held as still open for debate.

After assuming the presidency of the Royal Society Huxley's attendance at the Royal College became less regular. Rumours of ill-health began to circulate, and his teaching duties devolved more and more upon his senior assistant, Howes. Meanwhile, I left South Kensington in 1885 on appointment to Glasgow, and excepting for his last appearance in proposing the vote of thanks to Lord Salisbury for his presidential address in 1894, at the British Association at Oxford, I rarely saw him after that date.

The Beginnings of Instruction in General Biology.

By Prof. S. H. Vines, F.R.S.

MY personal association with Prof. Huxley was connected with the courses of instruction in general biology which he devised and conducted in the early 'seventies at South Kensington. By his biological friends he was ever after known as "the General," a tribute, no doubt, to the value of the idea by which these courses were inspired, the idea of the unity of life. Zoology and botany were making rapid progress at the time, but rather in water-tight compartments: the students of the one science felt but little interest in the other, failing to recognise the close similarity of the aims, the problems, and the methods of the two sciences. Having propounded the doctrine of protoplasm as the physical basis of life, Huxley logically inferred that animals and plants represent two divergent lines of protoplasmic evolution from a common starting-point. It was to illustrate this line of thought that the courses in general biology were planned. They involved the detailed comparative study of a series of animals and of plants, representative of various stages of evolution. The original programme was published as a small book known as Huxley and Martin's "Elementary Biology."

The first of these courses was held in the summer of 1873, and lasted for about six weeks. The daily introductory lecture was given by Huxley himself, and then the students, who were, I believe, elementary school teachers, went into the laboratory to verify for themselves the facts which had been described in the lecture. This they did under the guidance of a staff of demonstrators, who, on this occasion at any rate, were fully worthy of their chief. Unless I am mistaken, among them were the late Sir Michael Foster, the late Prof. Rutherford, Sir E. Ray Lankester, Sir William Thiselton-Dyer, and the late Prof. Lawson, of Oxford. The laboratory work covered two hours in the morning and two in the afternoon; it was sufficiently arduous to tax the energies of both students and demonstrators.

The first course was so successful that it was repeated in the following summer (1874), but with a different staff of demonstrators. Zoology was represented by the late Profs. H. Newell Martin and Jeffrey Parker, and botany by Sir W. Thiselton-Dyer and myself. I was then an undergraduate of Christ's College, Cambridge, and was offered the appointment by Newell Martin, who was a senior undergraduate of the same college. It was a great, almost oppressive, honour to be introduced to Huxley as one of his junior assistants. However, he was most kind and encouraging, though he did not spare criticism when necessary on making

his rounds in the laboratory. His lectures were a revelation to me, so lucid, so well-proportioned, so convincingly expressed. It was altogether a memorable experience, an invaluable apprenticeship in the art of teaching science.

The course of general biology was not, I believe, repeated at South Kensington, successful as it had been: it was, however, reproduced widely throughout the country, and still survives in some places—Cambridge is, I think, one. But it seems to me that the original glory has departed: the great leading idea of the unity of life has been lost sight of, and the course tends to degenerate into the uninspired study of the details of structure of certain typical animals and plants.

Nevertheless, the fresh impulse that Huxley thus gave to biological study has not failed to produce lasting effects. It materially affected the teaching and study of botany in Great Britain, directing attention to the fact that plants are of interest, not merely from the systematic, *hortus siccus*, point of view, but also, and chiefly, because they are living things the mode of life of which, though different from that of animals, is equally the manifestation of those fundamental properties of the protoplasm of which both plants and animals consist. Botanical courses on these lines were conducted at South Kensington in the spring of 1875 and in the summer of 1876 by Sir W. Thiselton-Dyer, in both of which I acted as one of the demonstrators. Afterwards, a special professorship of botany was instituted there to carry on the tradition.

Huxley and Evolution.

By W. Bateson, F.R.S.

FROM time to time I am asked by students, botanical and other, Was Huxley a great man? Did he do very much? I have a clear answer. I say, if you were a zoologist you could not ask that question, for you would know that Huxley worked over almost the whole face of zoology, and that so much of modern classification and terminology is the product of his logic and "organised common sense" that if we turn to any text-book earlier than about 1850, when Huxley's operations were beginning, we feel ourselves in zoological pre-history. It is all very well to say that anybody who chose to look could see that starfishes, Holothurians and Medusæ should not be classed together and with various other creatures, but neither Lamarck nor Cuvier did notice that Radiata and Polyps were preposterous medleys. Most of the great groups at one time or another came under Huxley's attention, and his instinct for order and his morphological sagacity were so sure that his judgment has been generally accepted by his successors.

I am aware, however, that on the occasion of this centenary the services we are to commemorate are not those which he rendered as a great architect of academic morphology. To the world, scientific as well as lay, Huxley is chiefly famous as the champion of evolutionary doctrine, whose vigorous and skilful advocacy counted for so much in obtaining the favourable verdict of the public. The opportunity was prodigious. He had a splendid case. Among his opponents were persons of the highest consequence, some of whom for this particular contest were equipped with nothing beyond the complacency of ignorance. He was, moreover, willing to take pains—a very formidable qualification in a controversialist. Such papers as Huxley on Suarez, Huxley *v.* Gladstone in the matter of the Gadarene swine or the order of vertebrate succession, provided a rare entertainment, of which the like—to compare small with great—had scarcely been seen since Bentley's Phalaris; though without disrespect to the victors in those decisive engagements, one may perhaps doubt whether either of them went about their daily business loaded with quite the weight of extensive and peculiar learning which upon emergency they produced with perfect spontaneity to the confusion of their opponents.

Looking back over that critical period, we wonder at the persistent bad leadership of the opposition. The only weapon by which they might have impeded progress was one they never seem to have thought of using, namely, silence. Had authority contented itself with observing that similar notions had been promulgated not infrequently for nearly a century before without meeting the general approval of naturalists, adding possibly a few soothing and carminative words to the effect that, whether true or not, these technicalities left the fundamentals of revelation undisturbed, but disclaiming any particular interest in the topic, trouble would have been long postponed, perhaps avoided indefinitely.

If that course had been pursued, we professionals would be remembering Huxley as a sound naturalist and an acute observer, though scarcely perhaps on a scale amounting to a celebration. Geneticists certainly are not likely to forget him. Through all his triumphant vindications of the doctrine of descent as a general proposition, he never forgot the weak spot. Again and again he declared it to exist in "the group of phenomena which I mentioned to you under the name of Hybridism, and which I explained to consist in the sterility of the offspring of certain species when crossed

with one another" (1863).[1] In the same year he writes to Kingsley: "From the first time I wrote about Darwin's book in the *Times* . . . until now, it has been obvious to me that this is the weak point of Darwin's doctrine. He *has* shown that selective breeding is a *vera causa* for morphological species; but he has not yet shown it a *vera causa* for physiological species But I entertain little doubt that a carefully devised system of experimentation would produce physiological species by selection, only the feat has not been performed yet."

Nothing that has happened since at all mitigates the seriousness of this criticism The words quoted above may indeed be used to-day with an even stronger emphasis, though I doubt whether many of those best acquainted with modern genetics are so sanguine as Huxley was, that by the most carefully devised system of experimentation are we in the least likely to produce physiological species by selection. Rather have we come to suspect that no amount of selection or accumulation of such variations as we commonly see contemporaneously occurring can ever culminate in the production of that "complete physiological divergence" to which the term species is critically applicable. With entire candour Huxley reiterated that if this were the necessary and inevitable result of all experiments, the Darwinian hypothesis would be "shattered." Nothing was to be gained by glozing that difficulty. The grounds of the evolutionary faith are otherwise so solid that no alternative can ever be considered again; but chiefly for the reason so prominently named by Huxley, which modern genetical research has so greatly reinforced, the representations of that process which found such facile acceptance in his time no longer satisfy us.

On another occasion Huxley's admirable scientific judgment came near to rendering a great service, if not to science, at least to Darwin. The manuscript of the Pangenesis chapter, published at the end of "Animals and Plants," was submitted to him for an opinion (1865). What he then replied we do not know, for the letter is not published among his correspondence, being, I imagine, lost But its tenor may be inferred from the sentence in Darwin's answer, "I do not doubt your judgment is perfectly just, and I will try to persuade myself not to publish." Huxley unfortunately weakened and replied that he had not at all meant to stop the publication, that he really should not like to take that responsibility, etc. So this curious chapter appeared, revealing that Darwin must have gone through life never apprehending the significance of cell-division, and almost without curiosity as to what was then already known of the process by which animals and plants are reproduced. From other passages the modern reader of course would suspect as much, but if Huxley's discretion had prevailed, illusion need not have been totally destroyed.

As we can now see very well, both Darwin and Huxley in a sense mistook the character of their own work. They were assembling materials and laying a foundation, well and truly, be it said, though, like so many of their contemporaries, they imagined they were finishing a permanent edifice. Huxley himself, as he stands in Collier's picture, confidently facing his audience with the skull in his hand, might almost be the model for Max Beerbohm's "The Future—as the XIXth Century saw it" Looking forward, the Victorian type sees his successor, the duplicate of himself, the same features, same proportions, same frock coat, only magnified enormously. In biology at least there were no misgivings in those days, and few attempts to look far behind the obvious. Genetics, the experimental study of developmental mechanics, and, in general, the prosecution of more rigorous analysis, are an independent development, related to what went before about as much as the arch was to the architrave.

Late in life Huxley attacked the Gentians, and after a year's work published his "Notes and Queries" on that natural order.[2] It was considered an admirable discussion, and I can believe it to be so The whole series of genera are there arranged in a logical order of inter-relationships based on the differentiation of the floral parts in adaptation to fertilisation by insects. To be sure, as he explicitly states, this consideration cannot be supposed to have decided the numerous other features of habit, or of leaf-structure, or the various other anatomical points in which the plants also differ, but he has "little doubt that, with larger knowledge, analogous causes will be found operative in all these cases." The "larger knowledge" to which Huxley is looking forward is to be the same kind of knowledge, only more of it. The knowledge his successors seek is of a wholly different order. No one better than Huxley knew that some day the problems of life must be investigated by the methods of physical science if biological speculation is not to degenerate into a barren debate. That ambition, which in Huxley's day was a pious and impotent fantasy, has become the immanent and informing hope in which all modern evolutionary research is directed The Gentians well illustrate the change; for I suppose we would resign ourselves to ignorance of the teleological meaning of their floral apparatus if some one would give us an analysis of the mechanical forces by which the flowers of *G. campestris* develop their parts in fours, and demonstrate how they

[1] "Collected Essays," vol 2, 1893, p 463

[2] Linnean Journal—Botany, 24, 1887.

are related to the mechanism by which many closely related species divide their flowers into fives.

Yet if our immediate aims are so distinct, our ultimate purpose is the same. In Huxley we shall always reverence one in the fruits of whose victory for truth and liberty we are still sharing. The direction of public opinion is a most precarious art, demanding imagination and a large knowledge of human nature. Of that art Huxley was an incomparable master; and the fact that thousands are now engaged without hindrance in the prosecution of those researches to which he devoted his whole life, is the direct result of his eloquence and courage. "Other men laboured, and ye are entered into their labours."

Huxley as Evolutionist.

By Prof. J. Arthur Thomson.

WHEN Darwin published his "Origin of Species" Huxley sprang at once to his side, and he never wavered in his loyalty to the general idea of evolution, towards which he had been previously not more than critical. On palæontological grounds alone, he tells us, he was quite convinced; and in the "flash of light" that Darwin gave him, he saw the evolution doctrine as "a statement of historical fact." This was partly because Darwin had a workable causal hypothesis behind the modal formula. As a champion of the evolutionist position Huxley did great service, in his American addresses for example, in showing how the formula fitted the facts, and in rebutting such criticisms as were begotten of ignorance and misunderstanding He was a fearless protagonist, "a braw fighter." He certainly quickened the not unnaturally slow acceptance of the evolution idea

Huxley was also favourable to the theory of natural selection, "the selective power, which Mr. Darwin has satisfactorily shown to exist in Nature"; but he was doubtful whether it was strong enough to bear the heavy burden laid on its shoulders.

"How far 'natural selection' suffices for the production of species remains to be seen. Few can doubt that, if not the whole cause, it is a very important factor in that operation; and that it must play a great part in the sorting out of varieties into those which are transitory and those which are permanent."

Why was Huxley doubtful? Because, as he says, the logical foundation of the theory of natural selection is incomplete until it has been definitely proved that selective breeding can give rise to varieties infertile with one another. Moreover, he said, it is necessary to know more about the raw materials on which the selective process operates—about the variations in fact and their causes. He had other difficulties, but these two were most important—the ordinary reproductive discontinuity of species and the nature of variations. Thus his fine-edged scientific temperament forced him to a *tätige Skepsis*—"doubt which so loves the truth that it neither dares rest in doubting, nor extinguish itself by unjustifiable belief." As Prof. E. B. Poulton has shown in detail, Huxley did not in the course of his life become either colder or warmer to what he called the *hypothesis* of natural selection. He continued to think that it was part of the answer to the evolution problem.

In regard to variations, Huxley was quite definite in distinguishing them from impressed "modifications" Speaking of Ancon sheep and the like, he said:

"Doubtless there were determining causes for these [varieties] as for all other phenomena, but they do not appear; and we can be tolerably certain that what are ordinarily understood as changes in physical conditions, as in climate, in food, or the like, did not take place and had nothing to do with the matter It was no case of what is commonly called adaptation to circumstances; but, to use a conveniently erroneous phrase, the variations arose spontaneously."

It seemed to Huxley intelligible that minor variations should arise, 'as intelligible as the general similarity, if we reflect how complex the co-operating 'bundles of forces' are, and how improbable it is that, in any case, their true resultant shall coincide with any mean between the more obvious characters of the two parents."

Impressed by such cases as the sudden appearance of the short-legged Ancon sheep or of hexadactyle children, Huxley kept hold of the idea of discontinuous or saltatory variations: "We believe that Nature does make jumps now and then, and a recognition of the fact is of no small importance in disposing of many minor objections to the doctrine of transmutation." He said that Darwin's position would have been stronger than it is if he had not embarrassed himself with the aphorism, *Natura non facit saltum*. It comes to this, that Huxley foresaw part of the truth that there is in the mutation theory; he had a glimpse of *Natura saltatrix*.

There is no doubt that Huxley believed in "an internal metamorphic tendency" as well as "an internal conservative tendency." The second is organic inertia and is expressed in individual stability and in the hereditary persistence of a specific organisation. As to the metamorphic tendency—to give rise to something new—Huxley thought of "a struggle for existence within the organism," an interesting anticipation of Roux's

"Kampf der Teile im Organismus" and of Weismann's "Germinal Selection." "Multitudes of these [molecules], having diverse tendencies, are competing with one another for opportunity to exist and multiply; and the organism, as a whole, is as much the product of the molecules which are victorious as the Fauna, or Flora, of a country is the product of the victorious organic beings in it."

One of Huxley's striking remarks was that the primitive protoplasm was like "a sort of active crystal with the capacity of giving rise to a great number of pseudomorphs; and I conceive that external conditions favour one or the other pseudomorph, but leave the fundamental mechanism untouched." As to the transmissibility of somatic modifications, he had an open mind—"I am too much of a sceptic to deny the possibility of anything"—but we do not know that he ever found any trustworthy evidence to lead him towards the affirmative position. In 1890 he wrote: "I absolutely disbelieve in use-inheritance as the evidence stands."

Huxley was evidently prepared to find evidence that "variability is definite, and is determined in certain directions rather than others by conditions inherent in that which varies." Like Darwin, he also attached importance to the idea of "correlated variation"; "the selective process carries the general constitution along with the advantageous special peculiarity," and the general constitution may express itself in variations that are *indifferent* as well as in those that are useful.

In his autobiography, certainly a remarkable document, Huxley says: "I am not sure that I have not all along been a sort of mechanical engineer *in partibus infidelium*." The only part of his medical course that really and deeply interested him was physiology, "the mechanical engineering of living machines." He speaks of the extraordinary attraction he felt towards "the study of the intricacies of living structure" He confesses: "I am afraid there is very little of the genuine naturalist in me"; and one cannot but remember how, when some zoologist asked him as to his manner of dealing with birds in a current course of lectures on comparative anatomy, he answered: "I intend to treat them as extinct animals."

We refer to this outlook because it explains, perhaps, what seems to us a marked limitation in Huxley's view of the "struggle for existence." No doubt he tells us that the struggle is more than "a sort of fight"; no doubt in the appendix to his Romanes lecture he refers to gregariousness, sociality, enforced "renunciation of self-will," and "rudimentary ethical process" among higher animals; but the fact remains that he gives the student an impression of animate Nature as "a vast gladiatorial show," "a Hobbesian warfare," "a dismal cockpit." Therefore man, he argued, in his endeavours after social progress must set his face in a direction opposite to that of Nature's regime.

Darwin's picture of the struggle for existence was broader and subtler. The formula must be used, he said, in "a large and metaphorical sense," covering all the thrusts and parries that organisms make against environing limitations and difficulties. It includes not only internecine competition for food and foothold, but endeavours to give the family a good send-off in life. Darwin's wide experience as a naturalist, studying the life of creatures as it is lived in Nature, made him not only clear in regard to the doom of the unlit lamp and the ungirt loin, but also appreciative of the time and energy that many animals expend in other-regarding activities which secure the safety and welfare of the offspring. The struggle for existence rises into an endeavour after well-being; and man must learn from Nature's tactics rather than seek to reverse them.

It seemed to Huxley that "perhaps the most remarkable service to the philosophy of Biology rendered by Mr. Darwin is the reconciliation of Teleology and Morphology, and the explanation of the facts of both which his views offer." The old teleology which pictured man's eye being made as it is in order that man should see clearly "has undoubtedly received its death-blow." "Nevertheless, it is necessary to remember that there is a wider Teleology, which is not touched by the doctrine of Evolution, but is actually based upon the fundamental proposition of Evolution"—to wit, a continuity of orderly becoming, according to definite laws, from the "primitive nebulosity" onwards.

Whatever primeval order of Nature we choose to start from, it implies the possibility of the origin of adaptable organisms and the establishment of a stable *Systema Naturæ*; it implies the possibility of man and his science; and, as Aristotle taught, there can be nothing in the end of a natural process of becoming which was not also present *in kind* in the beginning, whatever beginning we begin with. The one death-watch in the wooden clock, to use Huxley's comparison, said that he could find nothing but "mechanism." If this corresponds to the position of descriptive naturalism, it is quite right. But if the same death-watch went on to say that the clock was not contrived for a purpose, he would be quite wrong. But wrong in another direction would be the death-watch who maintained that the final cause and purpose of the clock was to tick, just as he himself did. The safer position would be to conclude that the purpose of the clock lay beyond the purview of beetle faculties. So, said Huxley, we must not be too sure that the cosmic ticking we hear is evolution's increasing purpose. These matters seemed to him out of reach.

Huxley as Anthropologist.

By Sir Arthur Keith, F.R.S.

IN the spring of 1857, two and a half years before the "Origin of Species" was published, certain events occurred in London which compelled Huxley to apply himself to the scientific study of the human body. As a student of medicine he had learned the elements of human anatomy, but from the time he left the Medical School of Charing Cross Hospital in 1846 until 1854, when he obtained his first teaching appointment in the School of Mines, his investigations had been confined to the structure of invertebrate animals. At the School of Mines he very quickly saw that if he wished to share in the prevalent movement which was then interpreting the faunas of past geological periods, he had to become a master of vertebrate anatomy. He planned a campaign which would carry him from one end of the vertebrate kingdom to the other, and proceeded to carry it out with all the greater zest because he knew it must bring him into open conflict with the first anatomist of the time—Richard Owen.

The contingency which Huxley had foreseen came about in the spring of 1857, while he was still in the prime of early manhood—being then in his thirty-second year—while his chosen antagonist, Richard Owen, was twenty-one years his senior and enjoying, as an undisputed right, the throne of leadership amongst British anatomists. At an early phase of his career Huxley realised that there was neither peace nor place for him in England so long as Richard Owen occupied that throne. The conflict, as we shall see, developed round man's status in the animal kingdom. In the course of the conflict which ensued, Owen was tumbled from his throne and Huxley emerged as the first anthropologist of his time. The future, when it is able to look back more calmly on these mid-Victorian happenings, will not wish to strip a single bay leaf from Huxley's brow, but it will desire to return to Richard Owen his crown. It was his arrogance and pride, certainly not his ignorance, which made him pay so dearly for two sad blunders he made in the spring of 1857.

Historians know well that the political events of a period cannot be interpreted aright unless the personalities of the statesmen of the time are known. It is so in science; the critical phase of Huxley's career cannot be understood or interpreted unless the contemporary doings and personality of Richard Owen are realised. In 1857 Owen found himself, for the first time in his life, without a pulpit and an audience: 1856 had turned out to be the critical year of his life; until then he had been Conservator of the Museum of the Royal College of Surgeons in Lincoln's Inn Fields; there for a score of years he had given courses of lectures, each course opening up some fresh section of the animal kingdom. This pulpit he had voluntarily abandoned because of a conflict with his masters—the Council of the College. The Council intended that its Museum should be conducted so as to serve the needs of medical men; Owen, in direct opposition to the Council, planned to make the Museum a national institution of natural history and comparative anatomy, controlled and supported by Government. He used his great influence at Court and in political circles to forward his aim. By 1856 he had made his office at College so uncomfortable that he determined, at the age of fifty-two, to transfer himself to the British Museum. That transfer ultimately culminated in the erection of the Natural History Museum at South Kensington, but its first effect was to deprive him of a platform whereon he might unload his ever-growing knowledge. Looking round, he had himself installed as a professor of palæontology at the School of Mines—the subject and place which Huxley was then making his own.

Herein Owen's arrogance led him to commit his first great blunder of 1857. Huxley sharpened his rapier and bided his time. At every opportunity he seized for investigation such subjects as had yielded fame and name to Owen; and when he seized them he shook them, and in the shaking Owen's errors dropped out so publicly that no one could fail to note them. Theories of skull and skeleton, over which Owen had been so elated when Huxley left the Navy, were mercilessly and publicly torn to tatters by his young antagonist. The monograph on the pearly nautilus, on which Owen first rose to fame, was shown to be blemished by errors. Owen had devoted himself to the study of the great fossil edentates of South America; Huxley gladly seized an opportunity provided by Owen's old College to show that he also could handle them as an expert. From 1830 onwards, Owen had made a special study of the anatomy of anthropoid apes; by 1857 he believed he had left little for others to discover concerning their structure. It was after 1857 that Huxley applied himself to the same subject. He did so because of a grievous and almost incredible blunder which Owen made in February of that year.

In 1857 Owen offered the Council of the Linnean Society a paper "On the Characters, Principles of Division, and Primary Groups of the Class Mammalia." The first part of the paper was read on February 17; in this Owen outlined his proposal to classify mammals according to the size and conformation of their brains. In his scheme, man was to be excluded from the order

of Primates, where Linnæus had placed him side by side with apes and lemurs a century previously, and placed far apart from apes in a separate sub-class. Owen demanded this separate place for man on account of the features of the human brain. We must look again at that passage in which Owen made his fatal blunder—the passage which turned Huxley to the comparison of ape and man, and became his stepping-stone to fame as an anthropologist.

"In Man the brain presents an ascensive step in development higher and more strongly marked than that by which the preceding sub-class [that to which were assigned the anthropoid apes] was distinguished from the one below it. Not only do the cerebral hemispheres overlap the olfactory lobes and cerebellum, but they extend in advance of the one and further back than the other Their posterior development is so marked, that anatomists have assigned to that part the character of a third (occipital) lobe; *it is peculiar to the genus Homo, and equally peculiar is the 'posterior horn of the lateral ventricle' and the 'hippocampus minor' which characterise the hind lobe of each hemisphere.*" (The italics are ours.)

This passage appears on pp. 19, 20 of the Proceedings of the Linnean Society (1858, vol. 2, Zoology), and that part of the passage we have placed in italics was a gross error. How Owen came to make such a blunder is not easily explained; it certainly was not for lack of opportunity of knowing the truth. Not even Huxley's merciless logic could wring from Owen an admission of blundering. He carried himself with the infallibility of a statesman in power. Huxley accepted Owen's error as a gift from the gods and shaped it into a lethal weapon. In reality the blunder was trivial, but to onlookers it seemed that man's soul was at stake, and Owen believed himself to be its chosen defender.

If it be difficult to understand how Owen came to make elementary blunders in the anatomy of the human brain, it is harder still to see how he could reconcile two statements which he set down on the page from which we have already quoted One statement is. "I am led to regard the genus *Homo* as not merely a representative of a distinct order, but of a distinct sub-class of the Mammalia for which I propose the name 'Archencephala.'" The other statement, which is here cut down to its briefest form, is this: "I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous—which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty." In one breath Owen announces that the difference between man and apes is so great that man must be assigned to a separate sub-class; in the next he declares that it is a matter of the utmost difficulty to draw a sharp line between ape and man. Owen clearly wished to leave himself the right to hunt with the hounds as well as to run with the hare; Huxley determined that his antagonist should run with the hare, and run hard.

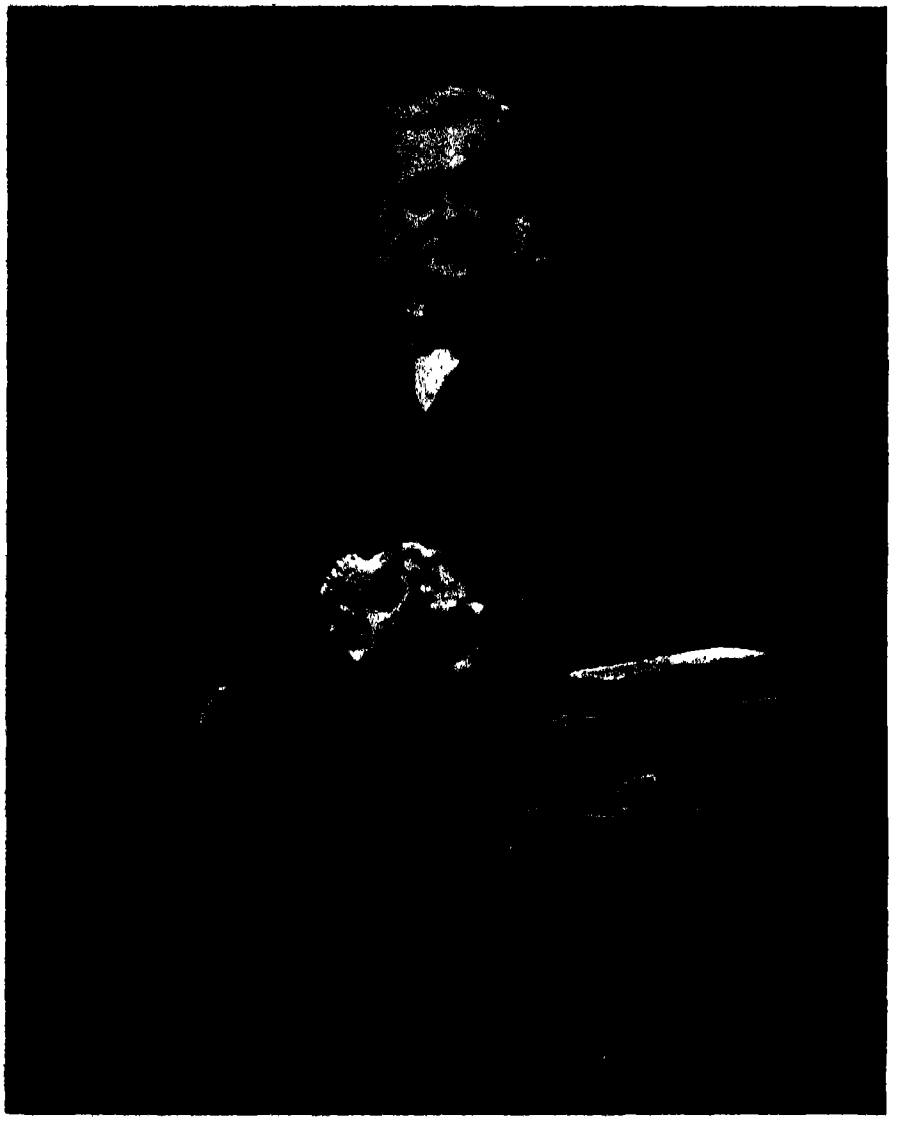
After Owen's paper to the Linnean Society was published, matters moved quickly towards a crisis. Huxley immediately set to work to equip himself with an ample supply of trustworthy ammunition and of followers, and was soon able to force Owen into action. Until then Owen believed that the ideas he entertained concerning the origin of man were daringly "advanced"; more than once dignitaries of the church had become alarmed over his tenets and teaching. In his youth he had basked in the sunshine of the smiles of the great Cuvier. He drew his inspiration from France. He believed, as Cuvier did, in a special creation of man: he also believed in a modified form of evolution—one in which "a predominating will produced structures for a final purpose" Huxley, on the other hand, so far as he drew inspiration from any source beyond his mother wit, drew it from Germany; the writings and methods of Johannes Müller, of von Baer, and of Koelliker were his chosen exemplars. Tradition and preconception regarding man's origin he had designedly thrown overboard, and resolutely determined to follow to whatever goal the evidence led him. Owen was blinded by the glamour of his own fame, which prevented his seeing the reality of the issues of the conflict which was being forced on him. He could not conceive that any one would be so foolhardy as to attempt to scale the battlements which the church had thrown round man's origin and divinity. Yet it was this foolhardy attempt which Huxley was to lead. He scaled the fortifications successfully and brought man back as a victim for the anthropological laboratory.

After 1857, as I have said, events moved quickly. In 1858 Darwin and Wallace read their conjoint paper at the Linnean Society; Owen was president of the British Association, and Huxley took the opportunity of blowing Owen's archetypal theory of the skull sky high. Late in 1859 came the publication of Darwin's "Origin of Species"; this provided Huxley with prime ammunition for his campaign. His guns, trained on the target of "special creation," were infinitely more effective weapons when loaded with Darwin's ammunition than when merely charged with the powder of pure negation. By 1860 Huxley had compared man and ape, bone for bone and structure for structure, and was then ready to place his conclusions before an audience of working men. Owen scoffed at this assay as an attempt to foist the gorilla on working men as their ancestor. It was in this year that Huxley made the meeting of the British Association memorable. There he slew Bishop Wilberforce with his wit and Owen with the "hippo-

campus minor"—a trivial but, as events proved, a murderous weapon.

Then in 1861 Huxley pursued his search into the manner in which the human and animal bodies are developed. Man, he found, had no prerogative in his mode of origin; his body came into existence by passing through similar stages in the womb as did that of the dog. In January of 1862 he went to Edinburgh to lay before the Philosophical Institute a detailed analysis of man's zoological status. In the summer of the same year he made a searching examination of such fossil human skulls as were then known. They were only two in number: one had been found at Engis in 1833, the other was discovered at Neanderthal in 1857. The Neanderthal calvaria he regarded as merely a primitive variety of the modern human skull. Its discovery had revealed the presence of a brutal race of modern (neanthropic) man in Europe at an unknown but certainly ancient date. For the accurate description and comparison of this skull he found it necessary to invent and apply a series of new methods; he sought to rationalise craniology. Then early in 1863 he issued the studies which Richard Owen's statements had compelled him to make in book form—"Evidence as to Man's Place in Nature." Huxley was the author of this classic, but Owen was its unconscious instigator.

When we look round for another biological treatise in which is given as complete and as convincing proofs of a thesis as were produced by Huxley in "Man's Place in Nature," we can think of only one which will stand comparison namely Harvey's account of the "Movement of the Heart and Blood." Such a comparison brings out a feature of Huxley's temperament. Harvey was Darwin's intellectual cousin; having set their evidence in its just order, they left it to speak for itself Huxley, on the other hand, favoured the methods of St. Paul and of Hume; it was not sufficient for him merely to set out his evidence in the clearest of terms and the most logical of orders; he felt it necessary to drive his arguments home with his unerring intellectual hammer.



Photo] [*Henry Dixon and Son*

1883

From a portrait painted specially for the National Portrait Gallery and presented, in August 1898, by Huxley's son-in-law, the Hon John Collier. Reproduced by kind permission of the Hon John Collier.

"Man's Place in Nature" has been studied now for sixty-two years; it reads as fresh and true in 1925 as in 1863. Its main thesis was to rehabilitate man in the

zoological position to which Linnæus had assigned him, namely, the status of a family in the order Primates. That status is now accepted by all. Anatomists are agreed that Huxley understated his case when he said that the structural differences which separate man from the gorilla are no greater than those which lie between the gorilla and the lower primates. Certainly our knowledge regarding man's relationships to anthropoid apes has increased enormously since "Man's Place in Nature" was written; we now know many extinct forms of anthropoid apes and fossil types of human beings, but such discoveries, while they extend, do not invalidate the truths for which Huxley contended except in one instance. This exception concerns the status of Neanderthal man. Huxley regarded this form of humanity as merely an extreme variant of modern man, while, in opposition to him, Prof. King of Galway maintained that the simian characters of the skull were so pronounced that Neanderthal man must be regarded as belonging to a separate and extinct *species* of mankind. Events have proved that King was right.

In writing "Man's Place in Nature," Huxley laid the basis for a true science of anthropology. By writing that book he rendered a great service to knowledge, but of even greater moment was the victory he then won in the cause of liberty. Until Huxley appeared as their champion, anthropologists scarcely dared to state the truth as they found it; when he had silenced theological opposition, they were free to apply to the study of man the same methods as they employed in the study of other animals. He paved the way for Darwin's "Descent of Man," which appeared in 1871.

With the publication of "Man's Place in Nature," the first phase of Huxley's anthropological investigations came to an end, and in the same year, 1863, a curious combination of circumstances forced him into a second phase, one which was to last until 1871. In both phases his anthropological inquiries represented but side issues of his day's duty; his main zoological work went forward as usual. In 1843, when Huxley was in the second year of his medical studies, the Ethnological Society was founded in London; in 1863 it held its meetings in St. Martin's Place—on a spot now marked by the Irving statue. At this time its affairs had drifted into a precarious condition. The relation of the negro to the white man was being violently canvassed, and a young hot-headed fellow of the Ethnological Society, James Hunt, who wished to apply political methods to the study of races, carried off a large group of ethnologists to found a new society, the Anthropological. The saner members who remained in the old society prevailed on Lubbock, John Evans, Galton, and Huxley to join them. As a fellow of this society, Huxley gave his attention to the races of mankind. In 1864 he had encircled the earth as a hovering anthropological hawk—noting the distribution of the "persistent modifications" of mankind, and as usual laid the first results of his survey before an audience of working men. The final result was published under the title of "The Methods and Results of Ethnology." This survey, if brief, is certainly comprehensive, logical and masterly, and has never been excelled. Darwin's theory helped him to explain much that was previously inexplicable. He applied to the study of human races the methods used by zoologists in the study of breeds of dogs. In his discrimination and classification of races he relied more on skin colour and hair texture than on form of skull, and in this, I think, the future—although not the present—will support him. He brushed the cobweb of racial tradition from the map of Europe and boldly declared there were but two racial stocks in Europe—a fair and a dark. The first he named the Xanthochroi; the second the Melanochroi. In each of these, round heads and long heads were found. So far as he could see, these two stocks had always been in Europe and no others. He recognised that there was a third racial element in Europe, the Mongolian, but this he regarded as eruptive and unimportant.

It may also be worthy of note—particularly as the subject is of present interest—that in this essay of 1865 the sceptical Huxley was a believer in "independent origins." He believed that all the world over, men were endowed with like faculties, and that "like faculties must tend to produce like contrivances."

In 1866 his friend, Mr. Samuel Laing, M.P., discovered in Caithness human remains which had been buried in stone-slab graves. These graves the discoverer believed to be of neolithic date, but they are now assigned to about the beginning of our era. Huxley gave a perfect description of the skulls and skeletons, and took the opportunity of expounding, for the first time, his conception of the racial composition of the British people. He brushed the traditional belief of Celt and Saxon aside. For him there were but two racial stocks in Britain—the same two as occupied the continent of Europe—Xanthochroi and Melanochroi. The fair-haired people, he demonstrated, had been in Britain long before the Saxon invasion. Huxley was always inclined to carry the simplification of his explanations to an extreme point. As a zoologist he could not accept the politician's conception of race, and yet we who have lived through the thirty years which have elapsed since his death have seen that the most violent racial animosities can arise between peoples of the same structural constitution. In the following two years, 1867, 1868, he was again studying human skulls and elaborating methods to elicit the exact nature of racial distinctions. Then, in 1869, in the hope of amalgamat-

ing the two rival societies—Ethnological and Anthropological—he accepted the presidentship of the former, and held it until their fusion was accomplished at the close of 1870. Studies of the races of America and of the peoples of India, made during the term of his presidentship, are lasting illustrations of the manner in which ethnological inquiries should be conducted and set out.

It so happened at this period that the "Irish question" had entered one of its acuter phases. On Sunday, January 10, 1870, Huxley gave an evening lecture on the "Forefathers and Forerunners of the English People." The thesis he expounded was that which he had broached in 1866, namely, that there were but two racial stocks in the British Isles—the fair and the dark. In his opinion the people of Ireland, of Scotland, Wales and England had been compounded out of these two stocks. He held that there were no means known to anatomists by which the body of a Celt could be distinguished from that of a Saxon. "If what I have to say in a matter of science," he informed his Sunday evening audience, "weighs with any man who has political power, I ask him to believe that the arguments about the difference between Anglo-Saxons and Celts are a mere sham and delusion." Having tried the effect of his facts and arguments on a popular audience, he then took them, as was his custom, before an expert tribunal, in this instance that of the Ethnological Society. In the following year, 1871, he issued his thesis in its final form under the title of "Some Fixed Points in British Ethnology."

The Sunday evening lecture led to a correspondence in the *Pall Mall Gazette* with a "Devonshire Man." I mention this correspondence here because it provides an example of Huxley's controversial methods. In his lecture he had flouted the idea that Devonshire men were preponderatingly of Anglo-Saxon stock, and on this point was challenged by a "Devonshire Man." Huxley's reply is well known, but is worthy of requotation on this occasion.

"Sir, your correspondent, 'a Devonshire man,' is good enough to say of me that 'cutting up monkeys is my forte and cutting up men my foible.' With your permission I propose to cut up 'a Devonshire man,' but I leave it to the public to judge whether, when so employed, my occupation is to be referred to the former or to the latter category."

After 1871 Huxley's health became bad; he was deeply involved in matters educational, geological, zoological, physiological and sociological, and abandoned anthropological studies. It was not until 1890, when he had retired to Eastbourne, that he contributed to the *Nineteenth Century* a paper which showed that he had not lost his old interest in anthropology. The title of this paper was "The Aryan Question and Pre-historic Man." As we read that article we see that Huxley's intellect had lost nothing of its great sweep and vigour; his gift of selecting from a confused mass of evidence the salient and significant facts amounts to genius; no barrister could excel his method of marshalling facts to prove a case. In this instance, the thesis he maintained was that, of all the peoples known to us, the fair-haired stock of northern Europe had the best right to regard themselves as the original Aryans, as the speakers of the mother tongue which in the course of time had become disseminated in daughter forms from India to Ireland. That theory was not new even in 1890; in later times it has been applauded and extended by German philologists.

When we read over at the present time the contributions which Huxley made to anthropology, we are struck by their modernity; very little of what he wrote requires to be deleted or altered. It is true that much could be added to the statements he made. Since his time our knowledge of the developmental and geological histories of man and ape have grown apace, but in most instances our increased knowledge leaves his broad truths unchallenged. No doubt the facts which we have learned concerning the antiquity of civilised life in Mesopotamia, Egypt, and Crete, and of the early spread of culture to western Europe, would have led him to reformulate his answers to certain problems. I am certain that the discovery of implements of human workmanship, in deposits of Pliocene date, would not have surprised him.

When we search for the means which so often guided him to the heart of the truth, we find them to lie within himself. No man ever purged himself more free of prejudice, preconception, and tradition than did Huxley. His controversial methods show us that he still retained in the outside world something of the original Adam; but inside his laboratory he attained as near the ideal of pure rationalism as is ever likely to be reached by any mortal biologist. His intellect was penetrating and balanced; his capacity to toil and to verify, unlimited. Because of these qualities his writings stand the test of time. There is perhaps a further explanation. He never permitted his imagination to stray far in front of his reason; he never gave his imagination free wing to open up new fields of knowledge or to outline a new or daring hypothesis. He had studied living matter in all its forms; in this respect there was no one in England during the nineteenth century who could be compared with him except Owen, and in precision of knowledge and in his familiarity with the physical forces which underlie the manifestations of life he was Owen's superior. These, I think, are the qualities which give to Huxley's contributions to anthropology and to all departments of biological knowledge a permanent value.

Evolution and Man.

By Edward Clodd.

HUXLEY'S career from the dismal time of his boyhood when, as he said in a letter to Charles Kingsley, he was "kicked into the world without guide or training or with worse than none," to the closing years, the strenuous activities in which only death arrested, needs no "vain repetition" in this brief article. Its main purpose is to emphasise the deep significance of his contributions to a theory which if it works anywhere works everywhere.

As with Darwin after his five years' experience in the *Beagle* (when he sailed on that memorable voyage Huxley was a lad of six), so with Huxley's four years on board the *Rattlesnake*, there was laid the foundation on which his life-work was based. At the unusually early age of twenty-six, recognition of what he had done thus far came in his election to fellowship of the Royal Society, the presidential chair of which he was to fill thirty-two years later. Besides the nine volumes of his "Collected Essays," four big volumes of "Scientific Memoirs" witness to the amazing amount of work which he accomplished. The public has judged him only by the "Essays"; the specialist alone knows to what high place as a philosophical biologist the "Memoirs" bring evidence. In their preface to these the late Sir Michael Foster and Sir Ray Lankester say that

"Huxley produced so great an effect on the world as an expositor of the ways and needs of science in general and of the claims of Darwin in particular, that, some, dwelling on this, are apt to overlook the immense value of his original contributions to exact science. Ignorance as to this exists in so-called well-informed circles. In his capacity of editor of a book entitled 'One Hundred and One Great Writers,' the late Dr. Richard Garnett is responsible for the statement which describes Huxley as 'the man who makes few original contributions to science or thought, but states the discoveries of others better than they could have stated them themselves.' Another sciolist, who shall be nameless, calls him 'that uncouth pedagogue of science.'"

Huxley's public activities, which included much lecturing, frequently to working-men, date from 1854; but he came more to the front on the publication of the "Origin of Species" in 1859. *Annus Mirabilis*, for from that time the saying "old things are passed away, behold, all things are become new," is applicable. The story of the mixed reception of that book is an oft-told one and has passed into history. In a letter to Wallace, Darwin said, "if I can convert Huxley I shall be content." His wish had quick fulfilment. In the chapter on the reception of the "Origin of Species," which Huxley contributed to Darwin's "Life and Letters" (vol. 2, ch. v.), he says, "My reflection, when I first made myself master of the central idea of the 'Origin,' was how extremely stupid not to have thought of that!" Pointing out what seemed to him a weak spot in the theory,[1] the disciple outstripped the master and filled the part of protagonist in a movement which was to change the current of thought on the absorbing question of man's origin, place, and destiny

On the last page of the "Origin" Darwin ventured only a hint that man was not specially created. When the "Descent of Man" came out in 1873 he explained that his reticence was "due to the wish not to add to the prejudice against his views" (Introduction, p. 1). Anthropology, the youngest of the sciences, had made little advance. In his "Memories of my Life," Sir Francis Galton says that the horizon of the antiquaries was so narrow in his Cambridge days (1840) that "the whole history of the early world was literally believed by many of the best informed men to be contained in the Pentateuch." So late as 1855, experts refused to accept the evidence of man's antiquity and primitive savagery which M. Boucher de Perthes unearthed from the Somme valley; and it was not until 1884 that the British Association for the Advancement of Science accorded anthropology a section to itself. Until then it was admitted only by a side door; a sort of "tradesmen's entrance."

To return to Huxley. Sharpening beak and claws, he opened the campaign in 1860 (we all remember the famous duel between bishop and biologist at the British Association that year). He pushed the theory of organic evolution to its logical conclusion in a series of six lectures to working-men in London, followed by two lectures to the Philosophical Institute of Edinburgh. These were published in 1863 under the title "Evidence as to Man's Place in Nature." The gist of what he said is in this quotation from what may, without exaggeration, be called a revolutionary book.

"In view of the intimate relations between Man and the rest of the living world, and between the forces exercised by the latter and all other forces, I can see no excuse for doubting that all are co-ordinated terms of Nature's great progression from the formless to the formed, from the inorganic to the organic, from blind force to conscious intellect and will. I have endeavoured to show that no absolute structural line of demarcation wider than that between the animals which immediately succeed us in the scale can be

[1] "In my earliest edition of the 'Origin' I ventured to point out that its logical foundation was insecure so long as experiments in selective breeding had not produced varieties which were more or less infertile and that insecurity remains up to the present time" (*ib.* p. 198).

drawn between the animal world and ourselves, and I may add the expression of my belief that the attempt to draw a psychical distinction is equally futile, and that even the highest faculties of feeling and of intellect begin to germinate in lower forms of life" (pp. 1089, 1863 edn.).

It was with pride, warranted by the results of later researches, that Huxley in a letter to me thus referred to the book when arranging for its reissue among the "Collected Essays."

"I was looking through 'Man's Place in Nature' the other day. I do not think there is a word I need delete or anything I need add except in confirmation and extension of the doctrine there laid down. That is great good fortune for a book thirty years old, and one that a very shrewd friend of mine implored me not to publish, as it would certainly ruin all my prospects"

The friend was Sir William Lawrence, to whom Lord Eldon had refused an injunction to protect the rights of the author on the ground that his book entitled "Lectures on Physiology, Zoology and the Natural History of Man" controverted the Scriptures. That was in 1819

The agitation which had been aroused by the lectures embodied in "Man's Place in Nature" was but a zephyr breeze when compared with the storm that raged round Huxley's lecture on the "Physical Basis of Life" which, exaggerating the offence, was delivered on a Sabbath evening in Edinburgh (November 8, 1868). In the limited degree to which people had thought about it, they had settled down with more or less vague understanding of it, into acceptance of Darwinism. Now their quiet was rudely shaken by this southern troubler of those "who were in ease at Zion," with his production of a bottle of solution of smelling-salts and a pinch or two of other ingredients representing the elementary substances entering into the composition of every living thing, from a jelly speck to man. Well might the removal of the stopper of that bottle take their breath away! Philosophers "so-called," and clerics alike, raised the cry of "gross materialism," never pausing to read Huxley's answer to the baseless charge, an answer repeated again in his writings, as in the essay in Descartes's "Discourse of Using One's Reason Rightly" and in his "Hume." He never wearied in insisting that there is nothing in his statements inconsistent with the purest idealism, and that our knowledge of matter is restricted to those feelings of which we assume it to be the cause.

Reference to the more important of Huxley's utterances would be incomplete if these did not include a few words of his lecture "On the Coming of Age of the Origin of Species," which was delivered at the Royal Institution on April 9, 1880. The occasion will not be forgotten by those who were present. Huxley was at his best; his note was one of restrained, well warranted triumph. One pregnant suggestion was that "if the doctrine of evolution had not existed palæontologists must have invented it" (the same remark, it may be added, applies to morphology and embryology). Huxley's closing words were congratulations to Darwin that "he had lived long enough to outlast detraction and opposition" and to see that "the stone that the builders rejected had become the head-stone of the corner." On April 26, 1882, Darwin was buried in Westminster Abbey.

From the nature of the subjects on which Huxley worked during his closing years, polemics could not be excluded. He agreed that "they were always more or less an evil." But to fold hands when error and obscurantism pursue their baneful course is a greater evil; hence the succession of controversies in which he was involved with Dean Wace and Gladstone. They need not be touched on here. Two years before his death he revisited Oxford ("adorable dreamer and home of lost causes") to deliver his Romanes Lecture on "Evolution and Ethics." His thesis was that the endless struggle which runs through Nature is for the time being checked by an ethic that has its roots in sympathy begotten of knowledge.

In the "Life and Letters" Dr. Leonard Huxley gives a series of portraits of his father from early manhood to old age. To these can be added a copy of a photograph given in Mr. Tuckwell's "Reminiscences" of Oxford, taken in 1860. He is depicted in a well-creased frock-coat, light waistcoat and baggy trousers, necktie with wide bow; in one hand he holds gloves and a silk top hat, and in the other an umbrella. The whole effect is comical. He looks for all the world like a stump orator. Never did clothes so belie the man.

Huxley's home life was ideal. In the Marlborough Place days, Huxley (I quote from a letter before me) had "a way of making Sunday evenings pleasant by seeing friends who come in without ceremony to take tea at half-past six." At these gatherings one had admission to a household, the note of which was freedom and simplicity; "a Republic tempered by epigram," as he described it. To name those whom it was a privilege to meet would be only to compile an index of eminent names; for of the things said and heard there could be no record: no "chiels amang ye takin' notes to prent." I recall one Sunday evening when a black fog reduced the guests to two—Mrs. W. K. Clifford and myself. Supper over, Huxley took me into his den, when he lighted his briar-wood pipe, and talk about books followed. Browsing among these, I came on an odd lot of obsolete theological and philosophical volumes which he said he had relegated to

"a condemned cell." From another shelf I took down Hobbes' "Leviathan," which called forth the remark, "I like that old fellow, his masculine and clear style is a tonic." His own style is *sui generis*. True workman as he was, he said to me that a book of his never came hot from the press without his wishing that he could rewrite it. Of his devoted and talented wife he said that she would have made a mark in literature "but for the claims of their big family." Evidence of her gifts is supplied in the slender volume of her privately printed poems,[1] a valued gift to those who hold her memory dear. It is from her "Browning's Funeral" that, at Huxley's request, these lines are inscribed on his tombstone.

> "Be not afraid, ye waiting hearts that weep,
> For God still giveth his beloved sleep,
> And if an endless sleep he wills, so best."

"There were giants in the earth in those days," and Huxley was among them.

[1] Since published by Duckworth and Co (1913).

Enduring Recollections.

By Dr. Henry Fairfield Osborn,
Research Professor of Zoology, Columbia University; Senior Geologist, U.S. Geological Survey; President, American Museum of Natural History.

I CANNOT decline to join in these tributes to my revered teacher, although the invitation from the editor of Nature finds me on vacation near the Coral Reefs of Florida and the Bahamas, far away from libraries, note-books, and letter files. It seems best to outline the enduring personal impressions of the memorable winter of 1879–1880 when the great anatomist and natural philosopher was in the full tide of his power.

Thoroughness, forcefulness, clearness, sincerity, and humour were the five outstanding qualities of Huxley as a lecturer. My two very full volumes of lecture notes, illustrated by copies of all his coloured blackboard drawings, display these qualities throughout, and I cherish them because they recall his dominant personality and also give a complete survey of our knowledge of that period of the zoology of invertebrates and vertebrates, of the cell, of embryology, of the palæontology and dawning phylogeny of the vertebrates. While at the time Huxley was on the crest of the wave of knowledge, these notes show how limited was our horizon in 1879 as compared with the vastly broadened horizon of this year of his centenary. His lectures, accompanied by daily laboratory verification under the genial influence of the younger W. Newton Parker and the omniscient prosector George B. Howes, were designed as a foundation for medical anatomy and physiology as well as for research work in comparative anatomy and palæontology.

When called to Princeton in 1880 as assistant professor of comparative anatomy, I introduced the Huxley method of extemporaneous lectures and laboratory verification to my college classes, and ten years later when called to Columbia University to lay the foundations of the department of zoology, I introduced the same method to the larger graduate and undergraduate classes. Thus through my under-graduate and graduate courses between the years 1880 and 1908, the broad Huxleyan method has been widely extended over the United States not only to my own students, such as McClure, Strong, Matthews, McGregor, Gregory, Lull, Osburn, Bensley, Forster-Cooper, Beebe, and many others, but to my grand-students, as I like to term the many able and forceful young men whom my own students are turning out from year to year. I cannot give exact figures, but I know that more than six hundred students are now profiting annually by this Huxleyan method in anatomy, neurology, embryology, and palæontology, in American, Canadian, and British universities.

Breadth and depth, culture from every source, lack of dogmatism, faith in the educational value of science without prejudice to the classics, these were the key-notes of Huxley's influence as a teacher and writer. From sheer necessity Huxley failed in one very important respect, namely, personal contact with his students; so far as I recall, he came through the laboratory not more than once a week, whereas Francis Balfour at Cambridge was at your elbow every morning. Thus Huxley had no time to encourage original thought or discussion or research with his students.

While having all the charm of extemporaneous discourse, his lectures, like his public addresses, were very carefully thought out, and fact was sedulously separated from opinion and hypothesis. On the dangers of extemporaneous speaking, Huxley once told me that he gave the closest attention to preparation beforehand, lest he should be carried away by the so-called "inspiration of the moment" to say something not strictly accurate. He also confided to me that he had never been able to overcome the apprehensive feeling known as "stage fright" before making a public discourse—a feeling that his talk was already as familiar to the audience as to himself, and therefore neither new nor interesting. This apprehensive feeling seems to be the best physiological prelude to a brilliant and convincing address. Our most easy and brilliant

American public speaker of recent times, Joseph H. Choate, also confided to me that before addressing a great audience he never could overcome his "stage fright" and extreme uneasiness.

When Huxley made his incomparable rejoinder to Lord Salisbury's attack on "the comforting theory of evolution" at the Oxford meeting of the British Association of 1894, he gave the impression of consummate ease and enjoyment, but he told me the following day that he had never found it more difficult to convey a compliment at the manner and form of the address combined with a complete dissent from the entire substance of it. On an earlier occasion at the annual dinner of the Royal School of Mines in 1879, when the presiding officer was so tactless as to criticise the policy advocated by Huxley of removal from the crowded quarters of Jermyn Street to the greater space of the South Kensington Science Schools, every eye was on Huxley, who as the guest of honour sat at the speaker's right; when he very quietly rose from his chair as the presiding officer concluded, some may have expected a characteristic rejoinder; certainly none of us foresaw the eloquence of silence, for bowing to the speaker, Huxley walked out of the dining hall as one could have heard a pin drop, and thus expressed his most emphatic disapproval.

Before leaving the subject of Huxley's candour and scientific caution and the extraordinary breadth and scope of his teachings and writings, from the widest ranges of Hume's philosophy to the anatomy of the amœba, I cannot refrain from directing attention to him as a leading and, in our specialistic days, much needed exemplar of the educational principle that in the highest grade of instruction we must be both extensive and intensive; we must cover a very broad field in an authoritative manner, we must penetrate very deeply in a single field. As to the latter element of intensive thought, Huxley was the first to observe that through palæontology we can penetrate far more deeply both in space and time than in any other branch of zoology. It was his personal misfortune and our own good fortune that he was so incessantly interrupted by public and educational affairs and the constant pressure for his opinion as a publicist on every theologic and scientific question of his day. It is no exaggeration to say that in his "Life and Letters" he has left priceless records of the conflicts of opinion during Darwin's time, records that are now eagerly sought and read by theologians and scientists alike, for their veracity as well as for their brilliance. Never is a truth sacrificed for an epigram; rather do truths shine out through his epigrams.

If in this polemic period of his life we perceive less scientific generalisation than we should expect from a man of such imagination and creative power, we may attribute it, first, to the lack of repose of mind necessary to generalisation; secondly, to the rudimentary and scattered materials of palæontology as he knew them in 1879. Huxley lived to see in the distance evolution as established by palæontology, but he did not live to enter this promised land; he came nearest to it in his brief visit to America and eager survey of the Yale Museum collections of Marsh establishing the evolution of the horse Now that we have taken full possession of the promised land of palæontology, vertebrate and invertebrate, and see before our eyes the secular origin of mutations, of species, of genera, of families, of orders, almost of classes, we wish we could summon the great spirit of Huxley back to life and walk along with him among the countless fossils we have gathered from every age in every continent, in their ascending order from the immovable Lingula to the ever mutable Homo. The palæontology of 1925 answers many of the biological problems of Huxley's day, such as the limits of variation, the powers of natural selection, the presence of determination rather than chance in evolution, about which he always expressed himself in the most guarded manner. In fact, the logical nature of Huxley's mind kept him in doubt as to the adequacy of Darwin's explanations of evolution, while in the larger sense he was the greatest and most able exponent of Darwin's doctrines.

In previous papers I have told many of the Huxley stories lodged in my memory. Without doubt some of Huxley's lecture jokes were annuals, like those for which Oliver Wendell Holmes became famous in his anatomical lectures at Harvard. Others were spontaneous and of the moment. He loved stories upon himself, as of his popular lecture on the brain and the one elderly dame whom he especially picked out to address as apparently the only intelligent member of an evening audience As the lecture closed this dame advanced for a question "Professor, there is one point you did not make quite clear to us: Is the cerebellum inside or outside of the skull?" This was a crusher. On his lack of orthodoxy, according to a story of youthful domestic experience which he told my wife, he was never rebuked so forcibly as in the early years of his married life by an intoxicated cook. After Mrs. Huxley had tried in vain to dislodge the cook from the kitchen floor, Huxley descended to the kitchen and with full assurance of masculine supremacy said: "Bridget, get up and go to your room, you ought to be ashamed of yourself." Whereupon Bridget gave a kick and replied: "I am not ashamed of myself, I am a good Christian woman, I am not an infidel like you."

On the personal side, it was my especial good fortune

as a young American palæontologist to be singled out of the class of one hundred students for a brief introduction to Charles Darwin on the only occasion in which he visited Huxley's laboratory, also to receive the hospitality of Huxley's delightful home at a time when his family circle was still unbroken. I treasure the visiting card on which he sketched the location of his home, 4 Marlborough Place, and invited me to come every week to his Sunday evening high-teas, as he called them. This gave me the opportunity of meeting Mrs Huxley and all the members of the talented family of sons and daughters, as well as the many clever and interesting artists and men and women of letters who surrounded the hospitable table. Here I saw the real personality of the man with all the cares and responsibilities of life thrust aside for the thorough enjoyment of conversation on every subject, rich and full of kindly humour, and with an inexhaustible fund of experience and wise counsel He loved to imagine that he was entirely ruled by his family and spoke of himself as chicken-pecked as well as hen-pecked. No one could have foreseen that he was so soon to break down in health and to be compelled to relinquish the load which was too great even for his broad shoulders and indomitable will and energy.

I saw Huxley later on two occasions and recall his witticism regarding the Gladstone articles in the *Nineteenth Century* on the alleged close correspondence between the actual order of evolution and the first chapter of Genesis. He said. "Osborn, that article of Gladstone's made me so angry that it acted favourably on my liver and caused me to discharge a large quantity of black bile which gave me almost immediate relief from the torpidity of that organ from which I had long been suffering" We enjoyed a long and delightful conversation at his home, in which he gave my wife an ever memorable talk upon his views as to the immortality of the soul Finally, in Oxford in 1894, at the garden party of the British Association, we met for the last time, when he was very much broken in health, and said to me sadly: "I am no longer able to keep up with the progress of biology; it has now gone far beyond me." One of my cherished letters is an appreciation from Mrs. Huxley of the address entitled "A Student's Reminiscences of Huxley," which I gave to the student assembly of the Marine Biological Laboratory soon after his death. I trust in the present brief tribute that I may have expressed again in some degree what I owe to his friendship and to his example.

Contributions to Vertebrate Palæontology.

By Sir Arthur Smith Woodward, F.R.S

In his brief autobiography (1893) Huxley mentions that in 1854, when Sir Henry de la Beche, the Director-General of the Geological Survey, offered him the posts of palæontologist and lecturer on natural history, he refused the former and accepted the latter only provisionally because he "did not care for fossils." He was much more interested in physiology, and did not at that time appreciate the purely morphological facts of palæontology. In a lecture at the Royal Institution in the following year, he even expressed the opinion that the study of fossils had not made any real contribution to the philosophy of zoology.

"There is," he remarked, "no real parallel between the successive forms assumed in the development of the life of the individual at present, and those which have appeared at different epochs in the past. . . . The particular argument supposed to be deduced from the heterocercality of the ancient fishes is based on an error, the evidence from this source, if worth anything, tending in the opposite direction."

After a very brief experience of his new field of research, however, Huxley began to be absorbed in the study of the fragmentary remains of extinct animals, and for more than thirty years he held his official position on the Geological Survey making fundamental contributions to palæontological science. He was at first associated with J. W. Salter, who had a special knowledge of the fossil invertebrata and was skilled in the naming of genera and species which were needed by the geologists for determining the relative ages of rocks. He accordingly turned to the fossil vertebrata which had until then been comparatively neglected by the surveyors, and he soon discovered their value not only as time-markers but also as affording important insight into the true relationships of many groups of animals which were otherwise difficult to understand.

Huxley's earliest paper, published in co-operation with Salter in 1855, was on some supposed fish-shields from the Upper Silurian (Downton Sandstone) near Ludlow, and this led to a series of investigations of the earliest fishes which by 1861 culminated in several entirely new conceptions. A detailed description of the microscopic structure of the head-shields of the Devonian Cephalaspis and Pteraspis showed that these really belonged to vertebrate animals, and none could be the shells of cuttle-fishes as had been asserted. A still more exhaustive study of the ganoid fishes from the Old Red Sandstone of Scotland was summarised in the now classic "Preliminary Essay upon the

Systematic Arrangement of the Fishes of the Devonian Epoch," which was issued as a memoir of the Geological Survey in 1861. Here, for the first time, the fringe-finned fishes (Crossopterygii, as they were then termed) were clearly separated from the higher and later types of ganoids, and a new idea was thus introduced into the classification of fishes. We now recognise that all the earliest fishes had lobate fins; that during the evolution of the more modern types these lobes have gradually become shortened up and replaced by long dermal fin-rays; that in the fishes which passed into amphibians the lobes were transformed into five-toed limbs.

Huxley maintained his interest in the Crossopterygian fishes for several years, and in 1866 he published another Survey Memoir on one particular group which he was the first clearly to define, that of the Cœlacanthidæ. After describing in detail the members of this group belonging to successive geological periods, he showed that they ranged in time from the Lower Carboniferous to the Upper Cretaceous with no essential change He had been impressed for some years with the numerous "persistent types" of life, as he termed them, but the Cœlacanths, with their complex and in many respects anomalous osteology, were the most remarkable of the long-lived groups which had then been discovered.

While studying the Devonian fishes, Huxley had been struck by the close relationship of some of them with the possible ancestors of the amphibians. He thus became interested in the earliest undoubted representatives of the latter class, which had been named Labyrinthodonts by Owen. He was, in fact, a pioneer in the investigation of the earlier Labyrinthodonts of the Carboniferous period, and he first described the now familiar Anthracosaurus and Loxomma from England and Scotland, besides an important series of small members of the same group from the Irish Coal Measures, and skulls from South Africa.

At the time when Huxley was devoting special attention to the fishes from the Old Red Sandstone of Scotland, specimens of these fishes were being found near Elgin in rocks which seemed to be of the same age as others containing the bones of fossil reptiles. He was accordingly induced to examine this question, and was soon able to prove that the two series of sandstones were really distinct, those containing the reptiles being of the Triassic period. In 1859 and 1869 he showed that the Elgin fossil reptile which he named Hyperodapedon also occurred in Triassic rocks in the south of England and in India, and when describing a complete skeleton from Elgin in 1887 he confirmed his previous impression that this early reptile was very closely related to the small rhynchocephalian Sphenodon which still survives in New Zealand—another "persistent type." A detailed description of many reptilian remains from the Elgin sandstone was given in a well-illustrated memoir published by the Geological Survey in 1877.

The bony scutes of one of the Elgin fossil reptiles, Stagonolepis, had been mistaken by Agassiz for the scales of a ganoid fish, and it was not until Huxley (simultaneously with Owen) recognised their true nature that their special interest was appreciated. They proved to belong to a reptile which in many respects suggested an ancestral crocodile. Huxley was thus led to examine the fossil crocodiles, and one of his most noteworthy papers was that "On *Stagonolepis Robertsoni*, and on the Evolution of the Crocodilia," published by the Geological Society in 1875. He showed, among other features, how the crocodiles had gradually acquired the secondary bony palate which enables them to drown their prey beneath water. It seems to be the earliest attempt to discover the genealogy of a group of reptiles, and Huxley emphasised the fact that, although he felt he had determined the successive stages through which the crocodiles had passed, he "did not suggest that the progression had been effected through the forms with which we happened to be acquainted."

It was natural to turn from the supposed ancestral crocodiles of the Trias to the Dinosauria, with which they are closely related. Huxley accordingly took part in the early discussions as to the correct interpretation of the skeleton of the Dinosauria, which had been completely misunderstood when these reptiles were first discovered With Cope and Phillips, he was the first to appreciate the bird-like construction of the hind limbs of many of the Dinosaurs, such as Iguanodon He even ventured to state that "if the whole hind-quarters, from the ilium to the toes, of a half-hatched chicken could be suddenly enlarged, ossified, and fossilised as they are, they would furnish us with the last step of the transition between Birds and Reptiles; for there would be nothing in their characters to prevent us from referring them to the Dinosauria." Subsequent research has not yet resulted in the discovery of the links which were doubtless anticipated when the foregoing statement was made, but there can still be no doubt as to the close connexion of the earliest Dinosaurs with the ancestry of birds.

Huxley had few opportunities for research on fossil mammals, though his papers on Macrauchenia (1861) and Glyptodon (1865) may be specially mentioned as models of exposition. He closely followed the researches of others, however, and so long ago as 1870, in an address to the Geological Society, he quoted with

approval certain pedigrees of the horse and other hoofed mammals which had been made out by Gaudry, Rütimeyer, and others. On his visit to America he studied the great collection of Tertiary mammals which Prof. O. C. Marsh had accumulated in the Peabody Museum of Yale University, and he helped Marsh in preparing the material for the latter's classic paper on the evolution of the horse in North America. Huxley's influence on the progress of palæontology, indeed, often extended beyond his own publications. The mere systematic work of defining and naming genera and species never had much interest for him; but he always keenly followed research which was guided by a clearly pre-determined problem. He had the peculiar faculty of deciding what was "worth while" at the moment, and his own writings on fossils, as well as those which he inspired, are all among the most important contributions to palæontology of his generation.

Structure and Evolution in Vertebrate Palæontology.

By Prof. D. M. S. Watson, F.R.S.

THAT Huxley was a great palæontologist cannot be disputed, but it is singularly difficult to estimate the extent of his influence and to determine the place that he holds in that group of students who, in the years following the publication of the "Origin of Species," brought to the study of fossil animals new ideas and a new spirit which revolutionised its methods and its aims.

The pre-evolutionary palæontologists, of whom Owen was the most distinguished English representative, had given most detailed and accurate descriptions of the skeletons of many individual extinct animals; and had in some cases gone on to discuss their appearance and habits of life on the basis of an analysis of their structure.

The extraordinary wealth of personal knowledge of muscular anatomy which Owen possessed renders his essays in this direction still of the greatest interest: but the bulk of the work of this period is of no interest save as a mine of facts, and indeed in many cases consists solely of short and valueless descriptions of new species.

Huxley's work stands in the greatest contrast to that of Owen, and indeed to that of all who had preceded him. In no single case did he describe a fossil simply because it was new. Every fact which he recorded was used for some definite purpose, for the elucidation of a point of morphology, or for its bearing on evolution. Thus his papers are still valuable and readable, not for the facts which he records (indeed, most of his information is drawn from the published work of other palæontologists), but for their spirit, and for the interpretations of data which they contain.

The work which perhaps best illustrates Huxley's methods is the paper called "Preliminary Essay upon the Systematic Arrangement of the Fishes of the Devonian Epoch." Here Huxley begins with an original account of the structure of the skeleton in certain fish from the Upper Old Red Sandstone. This account, though in the main accurate, is not comparable either for precision or completeness with the somewhat earlier description by Pander of similar fish. It would appear that Huxley used his less perfect specimens of Glyptolæmus very largely because they afforded a collateral corroboration of Hugh Miller and Pander's earlier accounts.

Being thus assured of the reliability of his data, Huxley goes on to a masterly analysis of the peculiarities of the Osteolepids, shows that they form a large group of fish, possessing a characteristic structure in head and fins, but very variable in body form. He shows that in the main, Dipterus is allied to them, and points out that only two living fish were then known, which had paired fins of the same "Crossopterygian" pattern. Of these fish, one, Polypterus, was definitely placed in the same group with the extinct forms, the other, Lepidosiren, being correctly compared with Phaneropleuron and Ceratodus, the latter then only known from fossil teeth. It is clear that Huxley regarded this group as close relatives of the Osteolepids. Finally, he adopts a suggestion of Egerton's, and with perfect justification adds the Cœlacanths to the "Crossopterygii."

So far the paper is a model of sound method, and has been one of the foundation stones of fish classification; but in the second half Huxley instituted a comparison between the Arthrodeir, Coccosteus, and the Siluroids, pointing out many resemblances, without apparently any suspicion that they are purely superficial and are superposed on a completely different fundamental structure.

In this paper, published in 1861, and even in others of later date, Huxley is engaged as a pure morphologist and taxonomist, concerned solely with the facts of structure of individuals, and a classification based on direct resemblances. He does not, and with the material at his disposal could not, discuss any evolutionary matters. Huxley's evolutionary outlook first appears in his work on Stagonolepis, a crocodile-like animal from the Trias of Elgin, whose structure is still incompletely known. This creature is represented by bones, in the main isolated and badly preserved, im-

bedded in a hard sandstone, and in studying it Huxley made use of a technical method—the removal of the bones and the making of artificial casts from the holes so left—which was carried much farther by his associate E. T. Newton, and is now one of the most widely useful of all modes of study. Huxley pointed out the thoroughly crocodilian appearance of the armour of Stagonolepis, turning aside in a series of small papers to give a full account of the dermal armour in many recent and fossil crocodiles. He showed that the vertebræ and limb bones exhibited the same affinities and then pointed out that, whereas the modern crocodiles have their palatal nostrils at the hinder end of the mouth, Stagonolepis and Belodon, then recently described by v. Meyer, resembled the lizards in the anterior position of these openings. Then, and it is in this feature that the novelty of the paper lay, he shows that in the Jurassic crocodiles, figured by Eudes Deslongschamps, and in a new skull from the Wealden, they lay in an intermediate position, the Cretaceous animal more nearly resembling the modern ones than did the earlier forms.

Huxley used the evidence so brought forward to divide the group Crocodilia into three grades, distinguished by their evolutionary stage, each division being in the broad sense ancestral to that which came after it. This was, I believe, the first attempt to establish a horizontal division of a group on a definitely evolutionary basis.



Photo] *[Henry Dixon and Son.*

1890.

Huxley in his study at 4 Marlborough Place, London, N W., where he did so much of his work All the details, the chair, the desk, the papers on it, and the books on the shelves behind him are faithfully represented. The books behind his head are mostly Darwin's works Reproduced by kind permission of the Hon. John Collier.

Huxley's palæontological work covered the widest possible range: representatives of all the classes of vertebrates were described by him, and he was continuously looking for intermediate forms the structure of which would serve to connect them together. It was from this viewpoint that he studied the Dinosaurs, finding in them so many structural resemblances to the birds, that he regarded them, as of all animals, the most nearly intermediate between birds and reptiles.

The palæontological work for which Huxley is perhaps most generally known is that on the evolution of the

horse, work in which he felt that, for the first time, we came near a real linear ancestral succession. To the data of this story he added nothing, but for the first time he arranged the then known fossil horses and horse relatives in their order of appearance, and showed how gradual was the reduction of the ulna and fibula. He recognised immediately the importance of Marsh's discovery of Orohippus and predicted the discovery of a five-toed horse ancestor, which still remains to be discovered.

As a palæontologist engaged in the actual work of examining, describing, and interpreting fossils, Huxley, although he takes an honourable place, has no pre-eminence. His work in this respect is perhaps not so good as that of his great rival Richard Owen In his power of determining the structure of fossil fish he was not the equal of C. H. Pander, and none of his work is comparable with that of W Kovalevski on fossil "ungulates," work permeated through and through by an evolutionary spirit, and directed continuously by an interest in function and habits of life which never appears in Huxley's palæontological work.

But Huxley's reputation is solidly based on those essays, of which his two addresses to the Geological Society are the chief, in which he directs his attention to a critique of the postulates which underlie all palæontological work His reduction of Cuvier's Law of correlation of structures to a mere empirical generalisation, to which many exceptions could be pointed out, removed what would have been a stumbling-block in the further development of the science His clear recognition of the difference between what he called intercalary and linear types amongst intermediate forms is a contribution of the first magnitude to the philosophy of the science; it lies at the base of all the later work on the filiation of extinct animals.

Huxley's distinction between homotaxy and contemporaneity, between rocks of different regions which contain identical or comparable faunas and those of the same age, is a fundamental one, necessary for a true appreciation of the evidence of fossils as to horizon, although it now appears probable that in most cases homotaxial formations are actually sensibly contemporaneous Nevertheless there are cases in which it does appear that the occurrence in two widely separate localities of animals of identical evolutionary stage does actually imply that these beds in that area from which the animals migrated are earlier than their homotaxial equivalents in the other region

Thus Huxley, in his palæontological work, is to be regarded as a philosopher, searching in the great mass of fact accumulated by his predecessors and contemporaries for facts which he could bring to use for the establishment of a morphological idea, for the improvement of a classification, or for use as evidence in favour of evolution

He was a critic, a man of most judicious mind, his caution being shown nowhere so well as in his failure, in 1862, to find any facts in palæontology to support the evolution theory, and at the time he worked he conferred an inestimable benefit on his science by his sure establishment of its intellectual foundations.

Geological Thought and Teaching.

By Prof. W. W Watts, F.R.S.

HUXLEY'S services to geology were mainly through his palæontological work, both in his original research and in his critical review of the work of others, largely with a view of testing its bearing on evolution. As he said on one occasion, "the sole direct and irrefragable evidence of the method whereby living things have become what they are is to be sought among fossil remains." Like Darwin, he was somewhat disappointed by the want of definiteness of some of this evidence, but, on the other hand, he was able to show that among certain types of life, phylogenetic chains could be made out. His faith in geological evidence is shown by his separation of the Elgin Sandstones from the Old Red Sandstone with which they had been formerly classed, and the placing of them in the New Red Sandstone division on the faith of their fossil reptilian remains.

When secretary of the Geological Society in 1862, Huxley was called upon, owing to the absence of the president, Mr Leonard Horner, to deliver the annual address In this he undertook the "wholesome though troublesome and not always satisfactory process which" is termed "taking stock." He directed attention to the number of "persistent types" in the animal and vegetable kingdoms, and the comparatively small amount of change from the earliest times in the major divisions of life-forms recorded as fossils. He clearly saw that the oldest known fossils were by no means the earliest forms of life, and that evolution demanded the existence of still older faunas and floras, some of which have since been established, though we are still far from knowledge of the beginnings of life on the earth. In the course of this address, Huxley examined and criticised the physical and palæontological evidence at the disposal of the geologist for establishing contemporaneity of strata in different parts of the globe, and showed that anything like exact evidence of synchrony was impossible of attainment. Existing faunas

in different parts of the world differ now from one another at least as much as successive geological faunas. He therefore advocated that the term "homotaxis," signifying similarity of order, should be substituted for contemporaneity as expressing more exactly the facts of the case.

The suggestion thus made has not been widely adopted among geologists working on stratigraphical geology, for several reasons. The geological scale, even in its most modern development, is not a delicate one in comparison with that of other histories, the periods of time represented by even small thicknesses of rock being long, and in the case of those most accurately zoned, of exceptional length. Wide-reaching migration is of course a slow process, but, expressed in terms of thickness of deposit, it is sufficiently quick to introduce no very serious error in paralleling widely separated formations with each other

The more striking distributional facts are concerned with the larger and higher animals, and those possessed of poor facilities for migration. The geologist, having tested the more slowly migrating types, has been driven to depend on more lowly and comparatively obscure organisms for his time indexes, and he chooses marine forms, of planktonic or pseudo-planktonic habit, with the greatest facilities for migration, and least sensitive to climatal variation. Then the geologist realises that his primary object must be to get out exactly the rock succession in each area studied, and the easiest and most satisfactory method is to establish steps as nearly comparable as may be with some type area Thus the comparison of deposits becomes increasingly exact and certain, and it then becomes possible for the first time to recognise geographical influences, to make out the facts of distribution as it affects individuals and groups, and to note cases of acceleration or retardation.

It is necessary after all (as with a currency) to take some standard, even a fluctuating one, and it is the task of the geologist to select that one in which the least possible variation is to be expected. It is not a little interesting to note that in his last address to the Geological Society (1870) Huxley speaks with appreciation of Barrande's doctrine of "colonies," a doctrine which for years held back detailed geological progress, and, in some of its consequences, seemed to stultify evolution. This doctrine, with all its unfortunate consequences, was destroyed by delicate British zonal research, carried out on the assumption that organisms were the best things that could be used as time-markers, and that, if well selected, they would provide a means of correlation, and a framework of contemporaneity sufficiently elastic to provide a basis of future research.

Huxley's first presidential address to the Geological Society, in 1869, was on wholly different lines. He spoke as advocate for geological science against the demand that "a great reform in geological speculation seems now to have become necessary." Clearly he was nettled by this reference to "speculation" and the refusal to admit that these speculations were founded on lines of reasoning to which a certain amount of respect was due. He opened with a masterly account of the early stages of geological thought as expressed in the schools of "catastrophism" and "uniformitarianism," and showed that these had given way to an "evolutionary" system, founded on that of Kant, which included the better parts of both. Then he proceeded to deal with the three branches of Lord Kelvin's argument, the tidal retardation of the earth, the age of the sun, and the cooling of the earth from a state in which life would have been impossible on it.

The first argument Huxley brushed aside on evidence presented by himself, and on other evidence either quoted or adduced by Lord Kelvin, as introducing compensations which it is necessary to take into account The arguments founded on the loss of heat by the sun and the earth he did not combat, but was prepared to admit that the history of the world, as known to geologists, might have been accomplished in the hundred million years or so allowed by Lord Kelvin Taking the total thickness of sedimentary rocks containing traces of life, as then known, at 100,000 feet, he pointed out that a history of one hundred million years would only require the deposit of one-thousandth part of a foot, or little more than one-hundredth part of an inch per year. No geologist would consider this rate excessive, especially for the types of sediment to which this estimate applies. As for biological evidence, "biology takes her time from geology. If the geological clock is wrong, all the naturalist will have to do is to modify his notions of the rapidity of change accordingly"

It is perhaps fortunate that Huxley had not to meet on this occasion Lord Kelvin's later estimates, for they could not have been met on the same lines. It has been necessary to wait until the physicists themselves have discovered a source from which the loss of heat is made good by the radio-active processes occurring within the earth.

The influence of Huxley's association with Tyndall is betrayed by his communication of observations made by himself in Switzerland on the structure and movements of glaciers. He was particularly interested in the veined structure of glacier ice and the evidence of pressure afforded by it. Afterwards he and Tyndall worked together and they are conjoined in a paper on the subject in the Phil. Trans. in 1857.

The interest in the sea-bed which Huxley acquired

as naturalist on the expedition of the *Rattlesnake* showed itself in his appreciation of all deep-sea work, including that of the *Challenger*, on which he wrote. It also appears in his popular lecture on "A Piece of Chalk," in which he pointed out that the deep-sea calcareous oozes give the best explanation of the wide extension, the great thickness, and the peculiar character of the Chalk.

In this lecture, as in another, also given to working men, on a piece of coal, Huxley displayed his wonderful gift of taking some new method of technique, describing the results obtained by it, and then leading his audience on to wider questions, each stage of the discussion being closely reasoned, illustrated by apt and unexpected analogies, and leading to important influences on the lives of his hearers. Thus his "chalk" lecture led on to a convincing demonstration of the antiquity of this deposit in comparison with the history of mankind, and to an appreciation of the vast and slow changes in geography which geology reveals. Similarly, in the lecture on corals and coral reefs, he is not content with describing the evidence of earth movement they reveal, but discusses its bearing on problems of distribution of life. In his lecture on coal, too, after illustrating the spores and other plant tissues in coal, and inferring the conditions necessary to produce coal-seams, he turns to show how the apparently reckless prodigality of Nature in dispersing these elements was the source of our coal supplies and of the industrial and economic applications which follow their exploitation.

One of the most important of Huxley's contributions to geology and geological teaching was the course of lectures which afterwards grew into his "Physiography." The purpose of this work is best stated in his own words.

"I conceived that a vast amount of knowledge respecting natural phenomena and their interdependence, and even some practical experience of scientific method, could be conveyed, with all the precision of statement, which is what distinguishes science from common information; and, yet, without overstepping the comprehension of learners who possessed no further share of preliminary educational discipline, than that which falls to the lot of the boys and girls who pass through an ordinary primary school. And I thought, that, if my plan could be properly carried out, it would not only yield results of value in themselves, but would facilitate the subsequent entrance of the learners into the portals of the special sciences."

It is not too much to say that the desire of the author has been attained, and that this book has had much to do with starting and stimulating many who have afterwards become distinguished in their work for geology and geography.

Huxley's Contributions to our Knowledge of the Invertebrata.

By Prof. E. W. MacBride, F.R.S.

HUXLEY'S original papers on the anatomy of the Invertebrata extend over a period of about thirty years, from 1849 to 1878. They deal with the most varied subjects, as, for example, the organisation of the Hydrozoa in general and of the Siphonophora in particular; the morphology of Heteropoda and Pteropoda amongst Mollusca; the anatomy and physiology of the rotiferan *Lacinularia*, the anatomy of the primitive trematode Aspidogaster, the embryology of the crustacean Mysis and of the parthenogenetic eggs of the Aphididæ amongst insects, and finally the anatomy of Pyrosoma, Doliolum, and Appendicularia amongst Tunicata.

The results recorded in these papers were embodied in a text-book entitled "The Anatomy of Invertebrated Animals," published in 1877. This was succeeded by the famous monograph on the crayfish published in 1880. In these two books we can see clearly displayed Huxley's outlook on the invertebrate division of the animal kingdom. In contradistinction to most of the zoologists of the day, he regarded classification as of secondary importance; what was primary and fundamental in his estimation was structure, and the only value of classification was to emphasise differences and resemblances of structure. Hence he gives no complete scheme of classification; he describes minor groups, and then discusses their probable affinities. Though, of course, he was a convinced evolutionist and one of the main protagonists for the cause in England, he held firmly that fundamental resemblances in structure constituted profound truths, the importance of which was entirely independent of the validity of any hypothesis as to how they had originated. He regarded the phylogenetic theories, which were fashionable in his day, as of no importance beyond serving to direct future research. As a consequence of this mental attitude he denied that there was any essential difference between so-called "artificial" and "natural" schemes of classification; he held that, on the contrary, they graded into another. He said that artificial classifications were based on some obvious external similarity, whereas natural classifications were based, so far as possible, on a consideration of all the likenesses and unlikenesses of the animals involved, and that these

features were selected as diagnostic marks which experience has shown to be indicative of a great many resemblances.

In both "The Anatomy of the Invertebrated Animals" and in "The Crayfish" Huxley takes up the extreme mechanistic attitude towards vital phenomena. In the former book he states that an organism is only a molecular machine of great complexity, and that to speak of vital force as anything beyond the sum of the physical and chemical processes which make up its working is as absurd as to speak of the horology of a clock. In "The Crayfish" he discusses the question as to whether the crayfish has or has not a mind, and declares it to be an insoluble problem. He points out the intimate connexion of mental ideas and images with language, and concludes that, since the crayfish has no language, it has nothing to say to itself or to anybody else, and that even if some of its actions are accompanied by an "awareness" distantly comparable to our own consciousness, this circumstance must be regarded as a mere epiphenomenon, and is of no avail to explain the actions in question; just as there are numerous things which we ourselves do without the intervention of consciousness.

Huxley's vigorous propaganda in favour of this way of looking at life had a profound influence on the scientific thought of his time, and this influence has by no means died out even yet. Nevertheless it is waning: when we learn from the works of Jennings that something of a rudimentary kind of intelligence—a questing after definite ends by varied means—can be detected in creatures so lowly as Amœba, we are not surprised that psychologists and biologists like MacDougall and Driesch come to the conclusion that there must be something analogous to a subject (a psychoid or entelechy) even in them. We may remark that if conscious intelligence is to be restricted to beings like ourselves, capable of thinking in verbal images and of carrying out syllogistic reasoning, this classification will deny intelligence in any form, just as surely to chimpanzee and to the human infant as to the crayfish.

In 1858 the Ray Society published a monograph by Huxley on the oceanic Hydrozoa, which embodied results already included in shorter papers read before the Linnean and Royal Societies. In this monograph we find Huxley's most important contribution to our understanding of the anatomy of the Invertebrata. This was an explanation of the structure of Hydrozoa based on the assumption that in every case their bodies were constructed out of tubes composed of two layers of cells, and of two only, an outer and inner. It was Allman, not Huxley, who conferred on these layers the names ectoderm and endoderm, but Allman followed and confirmed Huxley, who had first observed the fact and recorded it in a paper sent to the Linnean Society in 1847, but not read until 1849. In the monograph which we are at present discussing he takes the bolder step of comparing the outer layer or ectoderm of the hydrozoon polyp to the epidermis of a vertebrate animal, or rather of the vertebrate embryo, and the endoderm to the so-called mucous layer of the vertebrate embryo, which is applied to the yolk and draws nourishment from it. It is not too much to say that all our later knowledge of invertebrate development and anatomy is built on this foundation so well and truly laid by Huxley. Huxley points out that in invertebrates, as in us, the endoderm remains in a comparatively unaltered condition throughout life, whilst the ectoderm undergoes an enormous amount of modification in giving rise to cuticular, sensory, and nervous structures.

In making his generalisation Huxley lays down criteria of what constitute real homology or correspondence between two structures The first criterion is that two homologous structures must *develop* in the same way from similar parts of the body. The second criterion, which is to be used if a knowledge of development is not available, is that two structures regarded as homologous must be connected with one another by an unbroken series of structures of an intermediate character, each differing from the next by very slight differences. Fundamental unity of plan in the structure of an organism accompanied by wide variations in details was an idea which occupied a central position in Huxley's mind in all his dealings with animal life.

The second great contribution which Huxley made to science in the course of his studies of the Invertebrata was the discussion and definition of what was meant by the terms "variety" and "species." In his monograph on the crayfish he gives brief descriptions of crayfishes found all over the world, and deals with the question as to how the various "kinds" originated. He points out that the word species has two meanings, one morphological and the other physiological. A morphological species, according to him, is simply an assemblage of individuals which agree with one another and differ from the rest of the living world in the sum of their morphological characters. A physiological species, on the other hand, is a group of animals the members of which are capable of fertile union with one another, but not with members of any other group. Huxley also applies the term "physiological species" to the concept of the whole number of individuals supposed to be descended from an ancestor which had originated by an act of special creation. He goes on to say that the great majority of species described in works on systematic zoology are morphological species; that is to say, they are groups of similar animals, which

differ from all previously known animals by some definite character or groups of characters. Of course, as he remarks, the identity of the individuals making up a species is not absolute Apart from marks indicative of age and sex, children never resemble their parents exactly, but present small and inconstant differences from them, so that to collect together a number of individuals in a species merely means to assert that the differences between them are so small and inconstant that these differences probably lie within the limits of variation

As contrasted with a species, a "variety" or "race," according to Huxley, is the offspring of an individual in which a marked variation occurs, which is propagated to all its descendants; the variety is thus engendered within the bosom of the species, and, as Huxley says, if nothing were known of its origin it would have a valid claim to be regarded as a true species A race, however, may be generally discriminated from a species by the circumstance that its distinctive characters are not equally well marked in all the individuals composing it.

Therefore Huxley draws the conclusion that morphological species are merely provisional arrangements of animals indicative of the present state of our knowledge, and that it is impossible to say whether the progress of inquiry into the characters of any group of individuals may prove that what had hitherto been taken for mere varieties were distinct morphological species, or whether, on the contrary, what had hitherto been regarded as distinct morphological species were mere varieties. Huxley illustrates this by what had happened in the case of the European crayfish (*Astacus fluviatilis*). Milne Edwards had regarded all its forms as varieties of a single species, whilst Schrank had divided them into two species, namely, the stone-crayfish (*A. torrentium*) and the "noble" crayfish (*A. nobilis*), distinguished from the stone-crayfish by its deep red claws and its larger size. Huxley is inclined to agree with Schrank, because when both forms were introduced into a "crayfish" farm they refused to interbreed.

Huxley's estimate of the value of specific determinations has received many confirmations since his time Great Britain was supposed to rejoice in the possession of one peculiar species of bird, the Scotch "red" grouse, the nearest congener of which was the willow grouse of the Continent. When, however, the red grouse was taken to Norway, in about two generations it became indistinguishable from the willow grouse, and when the willow grouse was brought to Scotland it became changed in the same way into the red grouse In fact, it is becoming every day clearer that there is a continuous passage from a slightly marked local variety to a well-marked species, and so the question of the origin of species resolves itself into the question of the origin of these local races or varieties.

Huxley's views on this point read like a curious anticipation of "mutationist" doctrines. As we have seen, he attributes the formation of a variety to the appearance of a single abnormal individual or "sport." This view, we think, is no longer tenable. If by variety we understand a number of progeny artificially reared from a carefully selected pair of parents by man, then Huxley's opinion might be defended, but Darwin was more far-seeing in this respect than Huxley, for he says that he found that every strongly marked variety which he had observed occupied a definite "station" or locality Now the diagnostic characters which discriminate these "varieties" from one another are widely different from those which distinguish a sport from the fellow-members of its species. In the first case we have to deal with slight evasive peculiarities which affect the form and size of many organs, and these differences, as the example of the willow grouse shows, are almost certainly reactions to changed climate. But in the case of the sport we have a disharmony in the factors which operate in heredity to build up the body; this disharmony is due to the disproportionate weakness of some of the factors, and unless selection is constantly practised, if the offspring are exposed to normal conditions the disharmony will gradually disappear, and with it the characters of the sport. This result is attributed by the modern "geneticist" to reversion or "mutation backwards" (Morgan); it really is recovery from germ-weakness It is because of its physiological substratum of *damage to the germ* that the characters of a "sport" are so unequally developed in its progeny, as Huxley justly remarks.

Huxley's "Crayfish" not only summarised all that was previously known of the anatomy of this animal but also contains his own original observations; and it is to this book that we must go for the only detailed and clear account of the somewhat complicated internal or "endophragmal" skeleton. This skeleton is made up of the various "apodemes" or folds of inturned ectoderm which give support to the various muscles and perform the function fulfilled by bones in the vertebrate skeleton.

Huxley was not an embryologist, but his deep feeling for fundamental similarities of structure led him to make some astonishingly correct embryological guesses, which might almost be termed embryological prophecies. Thus he surmises that the formation of the endoderm by so-called "delamination" may be a modification of the older method of its formation by emboly or invagination; that the formation of the perivisceral cavity by pouches given off from the gut, such as occurs in Chætognatha, Echinodermata, and Brachio-

poda, may become modified so as to take the form of solid masses of mesoderm cells growing out from the gut, as is observed in the development of Arthropoda and Annelida. Both these views have received abundant confirmation in subsequent embryological research.

If we ask ourselves, in conclusion, what part of Huxley's work on the Invertebrata has endured and what part has proved to be of transitory value, we may answer that, in almost every case where discoveries were to be made by dissection and macroscopic observation, he has proved to be right, but that where microscopic investigation was necessary he was often wrong. This is not to be wondered at when we remember the extraordinary crudity of the means of preserving specimens and of cutting sections which were available in his day Thus he compares the pallial folds of the cephalopod embryo to the trochal ridges of the gastropod He regards the annelid Polygordius as a transitional form between Turbellaria and Polychæta, and Porifera as belonging to the same fundamental group as the Cœlenterata. The blood-system of lamellibranchs is said to communicate with the exterior by pores in the foot. Huxley asserts that the ovaries of parthenogenetic females amongst Insecta are fundamentally different from the ovaries of sexual females, he denies that the parthenogenetic ova are true ova; he regards all the parthenogenetically produced insects as portions of one individual; in a word, he confuses primary asexual reproduction by budding or fission with secondary asexual reproduction by parthenogenesis.

On the other hand, Huxley examined Peripatus, and pronounced it to be a true arthropod, allied to the suctorial Myriapoda, at a time when many of his contemporaries referred it to the worms or the Mollusca; he described most accurately the peculiar process of budding in the Tunicata, he refused to accept Agassiz's and Cuvier's view of the affinities of the Echinodermata with the Cœlenterata, a view which was expressed by relegating them both to a class Radiata, nor was he any more friendly to Haeckel's conception of an echinoderm as a budding worm, in which all the buds radiated from a centre. In view of the extraordinary metamorphoses of echinoderms, which start as bilaterally symmetrical animals and attain radial symmetry round an axis cutting the principal axis of the larva at an oblique angle, Huxley regarded them as a completely isolated group. Finally, we may say that no one can read the "Anatomy of Invertebrated Animals" without receiving the impression that he is being brought into contact with a great growing science, full of the most interesting and still unsettled questions, with promise of rich reward to the future researcher.

Processes of Life and Mind.

By Prof. C. Lloyd Morgan, F.R.S.

In Huxley's life-work there is a combination of the exact methods of inquiry which characterise the man of science with the breadth of interest which, in practice, distinguishes the man of affairs, and, in thought, betokens the philosopher. He claimed that all behaviour and conduct fell within his province as biologist, and that this should include all mental events which may accompany the actions of living beings.

From first to last Huxley stood not only for one method of scientific interpretation, but also for one order of Nature. Within that one order there are events that we call physical; there are events that we may call vital—those which occur only in living organisms; and there are events that we call mental—those with which we, and, as we infer, certain other living beings, are acquainted in diverse modes of feeling and under diverse forms of objective reference. If these be found in the Nature we seek to interpret, they should be loyally accepted as inherent in that Nature, and should be dealt with in accordance with the accredited methods of scientific policy. In brief, the outcome for Huxley was this: (1) All vital events in living organisms have a physical basis; that is, they occur only when certain physical events are also in being, and (2) mental events occur only when certain specialised physiological events are also in being

This does not imply, under (1), that vital events are physical only. They are distinctively physiological in that there are modes of action of a specific kind. There are biological as contrasted with abiological properties. None the less, they are physical also. Huxley could find no evidence of "connecting links" between biological and abiological events "Those," he said, "who take a monistic view of the physical world may fairly hold abiogenesis as a pious opinion, supported by analogy and defended by our ignorance. But as matters now stand (1886) . . . no claim to biological nationality is valid except birth." He was strict in his demand for evidence. Whether, in the light of such evidence as has since been adduced under new methods of scientific approach, he would soften the expression "defended by our ignorance," one cannot say.

Nor does the second clause of the above summary statement imply that mental events are physiological only. There is in them something new and specific.

None the less Huxley contended that, on the evidence, they have no being apart from certain physiological changes in a differentiated region of the central nervous system. There is a neural basis of mind, as there is a physical basis of life.

Cardinal throughout is emphasis on one order of Nature. There is no extra-natural insertion from a disparate order of being. This note was struck firmly and clearly in "The Physical Basis of Life" (1868). Even there the story of mind as accompanying the story of life, when it reaches a high level along certain lines of advance, was touched on in the concluding protest that he was no materialist, but, on the contrary, believed materialism "to involve grave philosophical error." He did, however, urge in effect that the story of life should be told in terms of physical and physiological concepts, whether they be accompanied by "states of consciousness" or not. He claimed "first, that the order of Nature is ascertainable to an extent which is practically unlimited; and secondly, that our volition counts for something as a condition of the course of events"—adding in a footnote (1892), "or, to speak more accurately, the physiological state of which volition is the expression"

Two years later the physical basis of life and the neural basis of mind were considered in the light of Descartes' "Discourse"; and, at the Belfast meeting of the British Association (1874), in the evening address on "Animals as Automata," he took up in further detail the accompanying story of mind, with stress on the hypothesis that animals, and men too, are conscious automata

For many then, and now, "conscious automata" involves a so-called contradiction in terms. If conscious, it is said, not automata, if automata, not conscious. Any such contradiction depends, of course, on the definition of the terms. No doubt they may be so defined that each is flatly contradictory of the other. Clearly, then, Huxley did not so define them.

One should try to grasp the interpretation of mind that Huxley was concerned to advocate. Whether the oft-quoted steam-whistle analogy and the statement that consciousness answers to the sound which a bell gives out when it is struck, serve their purpose well, is a matter of opinion. It may be said: Since no one attributes volition to the engine or feeling to the bell, why not consider rather the procedure of some one who is crossing the railway-lines, or is awaiting the summons to lunch? If we do so, then Huxley contends that it is not a "state of consciousness," volition or other, that is causally effective, but certain physiological action in the brain consequent on the stimulation of the sensory organ. It is in this sense that we are bidden, in 1892, to understand the earlier statement "that our volition counts for something as a condition of the course of events." Nor is this an after-thought. It is implicit in his thesis from first to last.

In the Berkeley Essays of 1871 and 1879, in dealing with St. George Mivart's criticism of "The Descent of Man" in the former year, and in the "Hume" of 1874, Huxley unfolded his reading of the metaphysics of sensation and showed the trend of his method of psychological analysis. One must remember that he wrote some half-century ago; one has also to fill in the implications of certain statements that he did not fully expand.

"States of consciousness"—this expression was then current—were regarded by Huxley as accompanying certain physiological changes in the brain. But consciousness as accompaniment in feeling—in enjoyment, as some now say—is only part of the story of mind. There is also that reference to something objective which Huxley spoke of as "extradition." In tactile sensation—more strictly tactile perception—the touch-datum concomitant with physiological events in the "sensorium" is "referred outwards to the point touched, and seems to exist there." In using a walking-stick "the tactile sensation, which is a state of our own consciousness, is unhesitatingly referred to the end of the stick; and yet no one will say that it *is* there." Huxley clearly indicates his view that such localisation is more than sensation only, since it depends, he says, on "ideas of relation." There is distinctively cognitive reference. In vision "every *visibile* . . . is referred outwards, in the general direction of the pencil of light by which it is rendered visible, just as, in the experiment with the stick, the *tangibile* is referred outwards to the end of the stick."

Although Huxley did not, in so many words, distinguish accompaniment in feeling from the going forth of reference under "extradition," it is implied throughout. When I asked him, in 1883, how he accounted for this extradition, the purport of his reply was: "There it is. It is given in our experience. We must take natural processes as we find them, and trace their development."

In cognitive reference, under the highly developed form which has been reached in adult human folk, there is clearly a valid sense in which it may be said that "what" is referred—the *tangibile* or the *visibile*—is "where" it is referred, at the stick-end or in Sirius. But it is so referred from the sensorium. "Here" is the source of reference to Sirius; "there"—if we acknowledge an external world—is the source of physical influence on the retina, and, through the intervention of a wave of action in the nerves, on the sensorium. As Huxley put it, in effect, we may ascend the hill of vision by two paths on opposite sides. One

path follows the influence from Sirius; the other path retraces the reference that goes forth to Sirius. One is material, the other is mental, each after its kind in the duality of Nature. Take which you will, they meet at the summit. Both are the outcome of a long process of evolution; so also is such accord as obtains.

Though, as physiologist, Huxley gave primacy to the material or physical path, as idealist he gave primacy to the path of mental reference. What know we of Sirius as a purely material existent—apart from reference in perception or under reflective thought? The light-waves received by the retina are separated from the brain-events which are concomitant with reference by many intervenient events of a specialised physiological character. That is so with all that is objective under percipient reference. Are we justified, then, on the available evidence, in saying more than that what is objective under reference is a world of mental symbolism, that, in Descartes' words, enables us "to walk surefootedly in this life"? Huxley thought not. But does this imply that mental symbolism counts for nothing in the course of events?



1895.

T. H. Huxley with his grandson Julian.

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Huxley's statements would have been clearer (if one may dare to say so) had he more emphatically distinguished cognitive reference from concomitant feeling—both included in "states of consciousness." But his contention comes to this: Without denying "that there may be a real something which is the cause of all our impressions," we may assert "that sensations, though not likenesses, are symbols of that something." It is in the concept of reference—or that of extradition, as he put it—and in the corollary of phenomenal symbolism that Huxley was idealist. In this sense "the more completely the materialist [that is, the physiological] position is admitted, the easier it is to show that the idealist position is unassailable, if the idealist confines himself within the limits of positive knowledge."

Strike out the concept of objective reference, leave in only accompaniment in feeling or enjoyment, and Huxley's thesis is shorn of full half of its significance. Seeing that the word "sensation" is ambiguous in that it may mean (*a*) the enjoyment which accompanies sens*ing*, or (*b*) that which is sens*ed* under cognitive reference, it does no injustice to Huxley's thought if the words in italics be substituted for "sensation" and "state of consciousness" in the following passage: "The great fact insisted on by Descartes, that no likeness of external things is, or can be, transmitted to the mind by the sensory organs; on the contrary that, between the external cause and *the centre from which mental reference goes forth*, there is interposed a mode of motion of nervous matter, of which *the object of reference* is no likeness, but a mere symbol, is of the profoundest importance" (1874).

Such was Huxley's concept of symbolic reference. Since his death it has been subjected to New Realist criticism, with emphasis on direct apprehension on the part of the mind. Vision, audition, and other modes of sensory acquaintance do not, it is said, afford only a highly evolved symbolism which enables us to walk sure-footedly; they reveal or disclose the very nature of the objective world, with its colours, sounds, and odours, perhaps also its beauty, quite independently of those instruments of apprehension which we call the

organs of sense. What Huxley's attitude towards the sensum-theory would have been one cannot say.

One may, however, surmise that his emphasis on one order of Nature, and his insistence on positive evidence of the scientific kind, would have remained unchanged. In the light of fresh evidence he might, were he still with us, concede that the evolutionary step from the cognitive reference of even the highest apes to reflective reference in human folk was greater than he allowed when he criticised Mivart and Wallace, and such as in some measure to justify on empirical grounds Descartes' distinction between the animal and the human mind. On the other hand, he might urge that the fuller knowledge we now have of the comparative anatomy and physiology of the brain still endorses his cardinal tenets—one order of Nature, one evolutionary process.

That mind is not an extra-natural insertion invoked to explain certain facts, said to be otherwise inexplicable, but is the outcome of natural advance, was the burden of his contention throughout. The highest attainments of reflective thought, the richest modes of symbolism in evolutionary ethics, imply a physiological basis, and without this would be non-existent.

In Huxley's day the locus of discussion was in respect of reflective thought. Now it extends downwards to the very basis of life Not only the volitional procedure of man, but his embryonic development, and the whole course of organic evolution, is in some quarters interpreted in terms of possession by an extra-natural entity that uses physical events in its endeavour to reach ends in some measure foreseen. What Huxley might have said on this head is a matter of surmise. But, apart from surmise, one can assert that it is not in accordance with the teaching we owe to him, or with the method of interpretation of those biologists who maintain what may be called the Huxley tradition.

The issue thus raised in new form since Huxley's death is one that primarily affects his philosophical opinions. It has, however, been said that, if the issue be decided in favour of what claims to be the new biology, Huxley's interpretation of life-process stands condemned That is not so. Within his special province of inquiry he was concerned to discover new facts and the plan of natural events of which these facts afford instances Surveying the whole field of Nature, he sought to formulate a comprehensive schema as the plan of all natural plans. In this task, to which he devoted great power with singular honesty of purpose, he believed that mythological concepts are worthless, and said so in language sufficiently clear and emphatic.

One has, therefore, to distinguish his positive contributions to the sum of human knowledge from his negative attitude in respect to the value of what he regarded as mythical. His positive work, like all good work, stands secure. It is for those who advocate mythological explanation to show in what manner it is of service in "improving natural knowledge."

Huxley as Teacher.

By Prof. Patrick Geddes.

LOOKING back to young days, a full half-century ago and more, I vividly remember how Huxley's influence first came upon me—and indeed to an extent mainly determinant for after-life, far beyond all other teachers, my father alone excepted; and, like him too, for substantial following, albeit necessarily also in each case with some elements of rebound Hence a personal opening and treatment may be clearest. I had been an eager field-naturalist from childhood, botanist and gardener too, mineralogist and rock-work builder; and at school had naturally revolted from its too conventional classics, and taken to the modern side. Hence purpose towards science, though in what specific line I could not clearly say, amid its many and varied attractions. During school days my wise father had given me a museum shanty, and next built me an outhouse laboratory and workshop. Then on leaving school, as I could not yet define my college ambitions, he encouraged me to various trials, as of chemistry (with some teaching from the nearest analyst), of mineralogy and botany, with a little geology too, and of the rudiments of zoology and physiology. The whole, too, with the summers free for varied roaming and voracious reading, by turns and together; to which he added also a brief but salutary and steadying experience of office and of workshop, as well as a period at the art school; and all this fundamentally upon his theory of self-education, though with reference and help on various sides as needed—a method I had enthusiastically adopted, and hold by still. Hence I felt happier than my old schoolfellows, by this time fully in the regular university or other mill; and I still feel fortunate in having been given these adolescent years, in freedom from all routine fixity and examination-pressure, and with studies pursued for their interest alone.

After nearly three years of this phase, my father and I agreed that it was now full time to be settling for university choice and course; and again he left these difficult selections to me. As botanical interests had by this time grown paramount, I first turned to Edin-

burgh; but the briefest of contacts with the too formalistic treatment which was then paramount there, disillusioned me, even to immediate revolt; and this all the more because I was fascinated by Huxley's "Lay Sermons," which were then widely spreading abroad a vision of biology on very different lines, and at deeper levels. Hence came quickly the solution of my difficulty—here is the master to whom I must go. My parents were alarmed, and naturally enough; for my father was an elder in the Free Kirk, and my mother had long hoped to see me in its pulpit Still, they met the situation cordially and well; in faith too—which increased my respect alike for them and it: so off to Huxley accordingly in 1874.

I had, however, a disappointment, for at the first brief interview with the great man he sentenced me to another preliminary year of chemistry, physics, and geology, before I should come to him. As I next got no credit from Dr Frankland or others for my years of unofficial studies, but had to begin all over again, this year gave little more than revisal of what I knew already, save that Ramsay's geology was a real stimulus. However, I had the wide resources of London—museums, collections and libraries, galleries and theatres too, thus continuing the self-education habit.

The good time at length came: so I had two years of Huxley His laboratory was open all day and every day throughout both winter and summer terms, though his lectures—always good measure over the hour (once nearly up to two hours, which left us exhausted!)—were in winter only. Never, of course, had I heard such lectures; or indeed since. Nothing could be clearer than his demonstrations of his well-chosen specimens, always sufficient for his exposition and argument, yet never in redundance; for his essential method lay in the educative value of the type-series and collection for the student, as compared with the redundant and bewildering wealth of the great museums. (Hence indeed one of his best-known gibes, that from the British Museum the London visitor mainly acquired sore feet, a headache, and an increase of his already amply sufficient thirst for beer!) His lucid explanations went on with the gradual and creative up-building of first-rate blackboard drawings in colour; which he left for us to incorporate, after lecture, on the plain page of our note-books opposite the written page His paper diagrams too were also of the best: not only the well-elaborated diagrams by G. B. Howes, who had already been for some time thus occupied, but also a good many from his own hand. Among these too there sometimes appeared a touch of the dry humour which now and then twinkled in the lecture: thus I particularly remember our delight over a fine sheet of half-a-dozen heads of leading genera of Primates, in which the profiles of the big-nosed Tyndall, the bearded Darwin, the bright-maned Duke of Argyll, as well as of himself, were unmistakably suggested upon the simian level.

For his laboratory too his claim was to be "a disciple of Mr. Squeers:—W-i-n-d-e-r, window: go and clean it! O-n-y-o-n:—onion—go and weed it!" for after morning lecture we had the whole day at dissection under his excellent demonstrator, T. Jeffery Parker, and with a daily visit from himself. For he had told us at the outset, "If you are to learn this subject (or I believe any other) you must apprentice yourself to regular all-time work at it, just as you would for any craft or trade. And if you can thus spend even a single winter term, these five months, you will then know something about biology which you won't forget all your life" I was soon convinced that he was right, and indeed remain so, so I have tried to apply this, so far as might be, in my own teaching life, and must we not increasingly come to some such concentration and thoroughness for all subjects? First the anatomist, and then the chemist, have longest thus been teaching; but the inroads of new subjects have too much made the student's day one of hour-fragments, like the school ones. But schools too are coming to longer periods; and so must university instruction also. Broader day-sections need not go on so long, and they leave more permanent results so Huxley here, as in other respects, knew his work as pioneering educator.

The practical class, with its first careful introduction to dissection and histology of his chosen type-series, from Amœba onwards, has long been too well known to need description here, but its in these days new and innovatory influence, as accompanying the corresponding lectures, and all as a broad introduction to later and fuller studies in botany and zoology—is even yet far from exhausted; nor can it ever be For here was the very first of laboratories, as also of lectures truly and broadly biological; and thus with our initiation to a not only elementary, but elemental, understanding of the various viewpoints of the science. Though necessarily mainly anatomical and histological, it was consistently and lucidly physiological too. Taxonomy was not stressed, but clearly indicated; and the larger physiology of Nature — ecology — early opened to us in its colours and perspectives. His introduction to embryology, as at once so protean yet so deeply orderly, was never to be forgotten; and his presentments of the palæontological record—as for reptile and bird, and above all for his favourite battle-steeds, the horse-kind—transmitted to us his clear and concrete views of their gradual evolution. His pupils could not but henceforth keep something of these varied outlooks, and in following their chosen one could no longer lose sight of

others. Thus one's latest publication, fifty years after —that of a little "Biology," with Prof. J. Arthur Thomson—is an endeavour to continue the like comprehensive introduction to the science.

Through all this breadth of presentation the interest of morphology stood out clearest and central to all: witness his quiet but unmistakable intellectual pleasure in lucidly setting before us the unity, yet variety, of each related series of organic forms, as for his especially beloved crayfish and lobster. After that, who could not but understand Goethe's term "Morphologie," and this not only as a culmination of his scientific work, but as perhaps the very greatest of his poems? Yet his interest in the various working of homologous parts was intense; indeed I remember him once sitting down beside me and, after giving me an illuminating explanation of my dissection, saying, half to himself, "You see, I should have been an engineer!"

I soon became a fairly good dissector, indeed, with Parker's care and Howes' example, we could not but do our best. By and by I grew fond of setting myself tests of skill, like dissecting out more neatly the growing point of Chara, the mouth-parts of Cyclops, and what not So I was one day greatly honoured by having a specimen kept for the museum, and with encouragement to go on making more I had several months of this, as the only second-year student, and thus, though quite junior of course to Parker and to Howes, I became something of a real assistant. One day, said Huxley, "You have been at this now long enough: it is time you started on a research of your own. Choose any subject you like, on which I can give you the material; and go ahead!" Next day he asked—"Well, what subject have you chosen?" I confessed I had not found one. "Well, well, think it over for a day or two!" But, alas, I remained as I was, for if his teaching had any fault, it was only too clear! His exposition of an animal, a part, a structure, was so perfect that it seemed to us finished, and leaving nothing to be said by him, or asked by us. "Well, well, I'll give you a subject to begin with!" So he got a whelk and a limpet out of pickle, and explained to me his view of the general mechanism of their horny tongue-cover, the "radula," as a flexible file, drawn to and fro by attached muscles, upon its cushion or "odontophore." So as he had never found time to work out this mechanism carefully, and throughout a series, I was set to this.

I worked away, and of course on his hypothesis; but gradually doubt began to arise. At first I was convinced I must be wrong; and so went over my dissections anew, day by day, and with fresh types also. At length, however, when he asked me, "Well, have you worked that out?" I ventured, very timidly of course, to express my difficulty. "No, no," said he; "look at that and that;—try again!" and so went off. Next day, "Well, have you got it clear?" "Very sorry," said I; "but it seems to me that the thing works just as a licking with the whole odontophore, and not a pulling to and fro of the radula." "Well, well, let me see." So I showed him the set of dissections I had prepared. He looked through them keenly for a minute or two—which seemed to me long! Then suddenly he jumped up, gave me a great slap on the back, and said, "'Pon my word, you're right! You've got me! I was wrong! Capital! I must publish this for you!" So he made me draw three plates, and write my paper, which he then presented to the Zoological Society, for its Transactions, and as a correction of a bit of his own work by a pupil. I had no vanity in the matter, for I had merely spent weeks over what he had probably only given an hour to; but his splendid candour, and real pleasure in getting a point of correction, was the very best of encouragements; since which I never again had difficulty in seeing far more problems for research than could be undertaken.

I searched Huxley's books and papers to see if there were any other little point I might try again to catch him on, but failed completely. so the upshot was more respect and admiration for him than ever, and alike as anatomist and as man. After that, too, his kindly interest increased. He found me a demonstratorship under Thiselton-Dyer and Vines for a vacation course, then discussed with Michael Foster and Francis Balfour their opening a career for me at Cambridge, whence a delightful stay with the latter of these. When I decided not to go on at Cambridge, but to Continental schools, he said "wait a bit"; and so put me up for the Sharpey physiological scholarship at University College; which carried with it the alternative of assisting Burdon Sanderson or of demonstrating for Schafer, of which I chose the latter. At the close of my first winter there I had a sharp illness, for which an Easter vacation change was prescribed: so said Huxley, "Go to Roscoff; I'll give you an introduction to my friend Lacaze-Duthiers." Hence to this I owed the first of the two or three delightful mind-stirrings of convalescence which have been epochs of my personal life. Nor was this his last encouragement and kindness.

All this, I hope, will not be misunderstood as self-centred but as illustrations of how the true teacher, even beyond his regular course, seeks to help his students on, and towards such continued productivity as they may be capable of. Since then I have wandered far, and into various other fields; but none the less it is but just as well as pleasant to record—along with appreciation of the biological thinker and educator,

the truly open-minded investigator—one's lifelong gratitude to the kindly and paternal "old man!"

What a pity that Huxley had never the great university position for which he was so supremely fitted! What a school he would have formed! Of course, as it was, his teaching was not lost, though his audience was too small—and that too much of mining students on one hand, and of science teachers in training on the other, to each of whom his class was but one of those to be gone through for their professional needs, respectively palæontological or pedagogic. Still, besides Jeffery Parker and Howes—of whom the former did well as professor of zoology in Dunedin, and the latter as his successor—as also Prof. Newton Parker of Cardiff, I remember among my fellow-students others who became biologists. First of all, of course, Lloyd Morgan; also Angelo Heilprin, later a notable American faunologist; and my especial friend, Dr. Angelo Andres, later of Naples and Milan. Of contemporaries otherwise educatively aided, I must cite William Hewitt, who after a fertile career of organising science teaching for Liverpool has lately been continuing Huxley's earliest and pioneering "Physiography" in his admirable "Survey of the Wirral District." Again, Ameer-Ali, since eminent as the essential founder of Aligarh University, the leading Mohammedan institution of learning in India, and now, though a busy Judge of Appeal for the Privy Council in London, has passed on his scientific interests to his son. Most unusual of us all, in his approach and interest, was the Rev. E. F. Russell, curate of St. Alban's, Holborn, a fine spirit, who came partly to learn the needful biology towards better medical guidance of his poor parishioners, but above all as an open-minded theologian, determined to get some clear understanding of the evolution doctrine and its bearings on his faith, and this by giving a fair hearing to its prime exponent.

There must have been others, even in my years, and thus doubtless a good many throughout his long teaching life, who in their various ways have owed much to Huxley; as notably H. G Wells and C. V. Boys; and it would be of interest if each would write his own personal experience as I have mine But doubtless the comparative fewness, after all, of direct pupils may have nerved him the more for his wide and varied literary as well as scientific output, of which it is not my province here to speak; as also to those admirable lectures to great audiences of working men, which made him the foremost of pioneers of what is now the vast University Extension movement; of which the students thus also owe more than they know to Huxley as teacher

Huxley's Message in Education.

By Prof. H. E. Armstrong, F.R.S.

"Above the altar or what serves for one is a bust of Truth: it is in wax and unfinished."—Sir Arthur Keith.

I FIRST heard Huxley, little short of sixty years ago, when, as a young student of chemistry at the Royal College in Oxford Street, I tasted his lectures at Jermyn Street—in days before a single educational brick was laid at South Kensington. My mind was soon made up that he was above me and his subject one that would not serve my purpose, even if not beyond my attainment; the lectures were too didactic, the treatment too special and detailed for my taste. We handled nothing in those days: Thiselton-Dyer, Michael Foster and Ray Lankester were not yet his henchmen. Zoology was then a purely descriptive science and the real Huxley—the combative philosopher and logician—was in no way apparent: he gave us results but no method. As a lecturer, apart from his fluency, he made no special impression upon me, but his blackboard drawings were fascinating. I did not come into personal touch with him until 1884–85, when I was translated to South Kensington, one of the small band charged with the working out of a scheme which he had done much to promote. He took no special interest in us, however: to me, indeed, he always seemed distant, if not unsympathetic. Doubtless his mind was over-full at the time and his health bad. His outward manner was the more disappointing, as, from the beginning of my career as a teacher, I had been greatly influenced by his writings and was consciously anxious to tread in his footsteps. Few probably now realise how great his public reputation then was—how great a service he had rendered to education by his addresses and writings during the previous thirty years. Excepting Liebig, perhaps, no one had done so much to make scientific study known and respected. Liebig, however, was an experimental philosopher: we owe the introduction of the laboratory method to him before all others. Huxley, in the main, was outwardly didactic, with a definite tendency to pontificate: at heart he was ever the inquirer. No other interpretation can be put upon the words he used in a letter to the divine, Charles Kingsley, in 1860:

"Science seems to me to teach in the highest and strongest manner the great truth which is embodied in the Christian conception of entire surrender to the will of God. Sit down before fact as a little child, be prepared to give up every preconceived notion, follow humbly wherever and to whatever abysses nature leads or you shall learn nothing."

We have here the ruling principle of Huxley's life in a single sentence. Though a biologist by profession, he had the physicist's, not the naturalist's, outlook of mind and love of exactitude. A comparative anatomist of the very first rank, he was also an anatomist of society. still, his tendency as a teacher was mainly descriptive. Take, for example, his text-book of "Physiography"—a story delightfully set out but none the less a book of mere fact, without any attempt to display the method of discovery—which is the background of our modern progress. To my thinking, the treatment of the subject in no way fits the doctrine he himself laid down in his after-dinner speech in 1869, the year in which the lectures incorporated in the book were delivered, in expressing his "firm conviction that a complete and thorough scientific culture ought to be introduced into all schools"



STATUE IN THE CENTRAL HALL OF THE BRITISH MUSEUM (NATURAL HISTORY) BY E. ONSLOW FORD, R.A.

The statue was unveiled on April 28, 1900, by H.R.H. the Prince of Wales (King Edward VII.).

"By this, however, I do not mean that every schoolboy should be taught everything in science That would be a very absurd thing to conceive and a very mischievous thing to attempt. What I mean is, that no boy nor girl should leave school without possessing a grasp of the general character of science and without having been disciplined, more or less, in the methods of all sciences: so that, when turned into the world to make their own way, they shall be prepared to face scientific problems, not by knowing at once the conditions of every problem or by being able at once to solve it but by being familiar with the general current of scientific thought and by being able to apply the methods of science in the proper way when they have acquainted themselves with the conditions of the special problem"

What those methods were, in his opinion, is most clearly stated in the lecture he gave, in the autumn of 1880, on "The Method of Zadig" ("Collected Essays," vol. 4). He knew his mind at an early age.

"Science is, I believe, nothing but *trained and organised common sense*, differing from the latter only as a veteran differs from a raw recruit. . . The vast results obtained by science are won by no mystic faculties, no mental processes, other than those which are practised by every one of us in the humblest and meanest affairs of life."

These quotations are from a lecture delivered in St. Martin's Hall in 1854, when he was only twenty-four years old. It is obvious, from the remarks he makes in the Preface to the third volume of the "Collected Essays" in which the lecture is printed, that he was himself of the opinion that he had displayed the foundations of his belief in this early essay.

Where are we in comparison with where Huxley was seventy-five years ago? By "science" he meant what to-day is called scientific method—a term which has but a single and a clear meaning independent of

subject. The word "science" has now but a vague meaning at best and is too general in its implications. There is a growing tendency to narrow its application. To Huxley, I believe, it ever meant wisdom, especially in natural knowledge—never mere knowledge. Hence it was that he could advocate the cultural value of "science" in education. This is implied in the title of the 1854 lecture "On the Educational Value of the Natural History Sciences."

In 1868, in the essay "A Liberal Education and Where to Find It," Huxley says:

"What I mean by Education is learning the rules of this mighty game [of life]. In other words, Education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. For me, education means neither more not less than this."

Speaking in 1869, as an advocate of "the introduction of scientific training into the general education of the country," he specially advocated

"the introduction of physical science into elementary education, both because it may be shown to be indispensable to the complete training of the human mind and as a means of getting on."

In 1880, at the opening of the Mason College, Birmingham, the forerunner of the present University, Huxley delivered an address on "Science and Culture," in which he advocated

"scientific training" as the means of giving culture. "Culture," he said, 'certainly means something quite different from learning or technical skill It implies the possession of an ideal and the habit of critically estimating the value of things by comparison with a theoretic standard. Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations."

Literature alone could not supply this knowledge.

"I should say that an army, without weapons of precision and with no particular base of operations, might more hopefully enter upon a campaign on the Rhine, than a man, devoid of a knowledge of what physical science has done in the last century, upon a criticism of life."

I heard the Mason College address in 1880. What has happened in the interval? What has Birmingham done, what have the schools of university rank elsewhere done, to give "science" cultural value? Speaking at Birmingham, in the University, only in October last, asking this question, I could only say "that Huxley's message had been delivered to no purpose!" No student to-day seeks training in science to serve cultural ends but merely to "get-on in life," as professional training. What is far worse, it is not taught either in school or university as a cultural subject. It is not an integral part of the educational system, commensurate in the public eye with literary training and even more essential. On the technical side progress is astounding but the world is lop-sided in consequence; the public is in no way trained either to appreciate, let alone use, scientific method or to grasp the power of the forces it is using, which may easily be turned against it to its undoing. We may well take heed of the bann put upon Darwin recently in several of the American States [1]

Herbert Spencer, Huxley and their school overrated man's educability. They seem not to have grasped the fact that a weapon which is so novel and so all-powerful cannot and does not appeal to the vulgar mind. The use of a tool can only be taught by those who have learnt to use it: unfortunately, only the very few have command of true scientific method.

Huxley, probably, was a prophet delivering a message the meaning of which he had not himself fully grasped. Overwhelmed by the victories of innate genius, like Herbert Spencer, he jumped to the conclusion that genius could be imitated While saying ("Mr. Darwin's Critics") that "Ecclesiasticism in science is only unfaithfulness to truth," he overlooked man's innate tendency to worship ecclesiasticism, pure and simple. Examinations make it so. To-day physical doctrine is laid down as something absolute—not as tentative. No cleric was ever more absolute than is the modern cosmic physicist *Genesis* is not in it with a school text-book of chemistry. There is no sitting down before facts—facts are just used as brickbats for the poor boy to catch and throw back if he can.

If Huxley had put into his lectures on science *the method* which he used in his discussions with Mr. Gladstone and Dr. Wace, the position might have been made a stronger one. He was judicial and scientific when disputing—didactic when talking of the value of science. He was never, in fact, a direct teacher of scientific method, though, by implication, ever its greatest advocate. He thus gave proof, as we all do, that the mind is compartmented and that the compartments are not necessarily interlocked—indeed, often without means of intercommunication and mutual control.

If Huxley be read with the limitations I have ven-

[1] More and more, science is entering the service of Mammon: it is mainly worshipped as a means to material ends, not as being of the spirit and the one sure hope of a lasting religion This is strikingly illustrated by the selected School Prize Essays, written in a contest, in which 500,000 high school pupils took part, instigated by the American Chemical Society in 1923-24, published recently by the Society. The young essayists all dwell enthusiastically upon the material advantages to be derived from chemistry. No word is said of its method or of the fascinations of its disclosures—not a word to show that the spirit of science has found entry into the school. This too in a country which claims to be a land of ideals. Several books were circulated in the schools—among them "The Life of Pasteur" the great lesson to be learnt from this seems to have passed unnoticed.

tured to place upon his statements, he is infinitely inspiring. We have, more especially, to recognise that we have not yet even attempted to do what he urged should be done; that as yet we have in no proper way interpreted the message which he delivered, though in some degree unwittingly. If we will do so, we may yet achieve his aspirations. We can only do so, however, by recognising, each and all, our own great individual limitations and organising to overcome these Science is, as Huxley said, *organised* common sense. We have yet to make the attempt *to organise* the considered and judicial use of our knowledge in the interests of truth alone: on no other terms can science be made a moral force.

Progress in organisation is of all things the most difficult to secure—in Great Britain particularly We have only to take Huxley's plea for the reform of medical education made in 1870 Medicine to-day is in a far worse plight than it was then—the burden of fact laid upon students is ever increasing and one that is impossible for them to bear. Surgery, like all technical trades admitting of advance through experiment, has made the most marvellous progress; apart from what chemists have done for it, the cognate subject medicine can count little to its credit Scientific method is neither used nor taught in the early stages of the medical student's career. he is eternally crammed into stupidity. The advice given by Huxley in 1870 and again in 1880 and 1881 still awaits consideration: the medical profession will greatly fail in its duty if it do not soon put its house in order, more or less in accordance with his recommendations. As I began my career in 1870 by attempting to teach a little chemistry to medical students and have often discussed the problem of their education, I feel that it is about time that we recognise that, at least in medicine, Huxley's advice should no longer wait upon adoption. Medicine is likely to be more and more a branch of applied chemistry and it is intolerable that its practitioners should be so entirely without *chemical feeling* as they are

Huxley was of opinion "that stupidity, in nine cases out of ten, *fit, non nascitur* and is developed by a long process of parental and pedagogic repression of the natural intellectual appetites accompanied by a persistent attempt to create artificial ones for food which is not only tasteless but essentially indigestible."

Undoubtedly there is truth in this. I was once whole-heartedly of the same opinion but bitter experience, gained in the attempt to overcome stupidity, has convinced me that we should be nearer the truth if we were to substitute one for Huxley's nine, perhaps. I believe, however, that far more can be done to raise the general average that by aiming far lower we shall reach a higher level. Education, in its present form, started in the monastery: the system is still monastic—we have to make it worldly. There is a subtle influence, if not conspiracy, at work depressing the schools, the educational system being such that a particular type of mentality is selected from the community for its service: the literary type, an unpractical, unprogressive type. The teachers are learners rather than doers—with few exceptions they do not in the least understand how knowledge is won and used. The professor of education has been but a talker: he has seldom been a doer in the subjects he presumes to teach As the business of the world is to do rather than to learn, the selection made seems to be a wrong one.

We have spent fifty odd years in making a great experiment. Most valuable information has been won but not the desired result. The question is, Can we utilise our experience and extend the inquiry on the practical side? The quality of teacher the experiment will need is rare: herein lies our difficulty. The task is one of endless difficulty: herein lies our opportunity. Huxley is at hand, telling us that we must not shirk it. He, at least, has stated the conditions of the problem: in days to come, if our civilisation survive, his claim to rank among the prophets must be great indeed

Of the many addresses delivered by Huxley, none is of greater weight and public importance than that on "Evolution and Ethics," the Romanes lecture in 1893, his last public appearance. Perfect in literary form and transparent clearness of argument, it is a remarkable display of the breadth and intensity of his outlook—a final summary of the convictions and philosophy of a man of piercing insight who, all his life, had been a student of social problems In the lecture, he discussed the apparent paradox that ethical nature, while born of cosmic nature, is necessarily at enmity with its parent.

"Social progress means a checking of the cosmic process at every step and the substitution for it of another, which may be called the ethical process, the end of which is not the survival of those who may happen to be the fittest in respect of the whole of the conditions which obtain but of those who are ethically the best."

He was clear as to our duty: no words could be stronger than these:

". . . To my knowledge, nobody professes to doubt that, so far forth as we possess a power of bettering things, it is our paramount duty to use it and to train all our intellect and energy to this supreme service of our kind.

". . . The practice of that which is ethically best—what we call goodness or virtue—involves a course of conduct which, in all respects, is opposed to that which leads to success in the cosmic struggle for existence. In

place of ruthless self-assertion it demands self-restraint; in place of thrusting aside or treading down all competitors, it requires that the individual shall not merely respect but shall help his fellows; its influence is directed, not so much to the survival of the fittest as to the fitting of as many as possible to survive."

To use all but his own words, he was in no doubt that the cosmic process has no sort of relation to moral ends; that the imitation of it by man is inconsistent with the first principles of ethics. Still, though it might seem an audacious proposal to pit the microcosm against the macrocosm and to set man to subdue Nature to his higher ends—the great intellectual difference between ancient times and our day lies in the solid foundations we have acquired for the hope that such an enterprise may meet with a certain measure of success. "I see no limit," he said, "to the extent to which intelligence and will, guided by sound principle and organised in common effort, may modify the conditions of existence for a period longer than that now covered by history."

But to such end "We are grown men and must play the man

'strong in will
To strive, to seek, to find, and not to yield,

. . .

It may be that the gulfs will wash us down,
It may be we shall touch the Happy Isles,

. . . but something ere the end,
Some work of noble note may yet be done'"

Such was his last message. To-day, more than in his day, we need to give it heed, mindful of a far earlier exhortation:

Nought shall make us rue,
If England to itself do rest but true

The signs are ominous that we may have forgotten the conditions upon which success depends—perhaps in education especially In no way has "science" been made to tell ethically, except in medicine.

The Master.

By Prof. W. J. Sollas, F R S

IT is now about sixty years since I received my first teaching in science in the College of Chemistry and the Royal School of Mines, and as my friend and fellow-student, Prof Liversidge, lately exclaimed. "What a splendid education it was." Frankland, Tyndall, Ramsay, Smythe and Percy, a brilliant staff, guided us through an ideal curriculum, and thus prepared we proceeded, in 1868 I think, to Huxley, who in teaching us zoology, taught us a vast deal more besides.

I recall our first gathering in the lecture room of the Museum of Practical Geology. A few earnest students were seated round the green baize table immediately below the lecturer's desk; the surrounding seats were almost, if not quite, empty. Punctually at the stroke of the clock Huxley entered the room and commenced his introductory lecture, which was devoted to a philosophical analysis and classification of the subject-matter of the "Science of Living Things," or, as he termed it, biology. I recall a slight feeling of disappointment, for I had expected to be plunged at once *in medias res*, but the lecture set me thinking; it clarified and systematised my ideas, and had a general, as well as a special, application. I have shown my appreciation of it since in the sincerest way by borrowing it wholesale and using it in an adapted form as an introduction to the study of geology.

As the course proceeded and knowledge increased, I began to perceive certain incidental qualities which had hitherto escaped my attention. One was a precision in the use of scientific terms and a nicety in the choice of words in general—always the right word in the right place At first this was a source not only of enjoyment but of terror, for after the lectures loomed the inevitable examination, and it was obvious that as the master treated us, so in that day of dreadful judgment would he expect us to treat him.

From words we pass to sentences, and these were always concise and simple, yet so clear as to leave no room for doubt or ambiguity Man is before all an imitative animal, and so these lectures in zoology became also a lesson in the English language.

As the language so the subject, first the facts given in precise detail and natural sequence then embodied in a logical scheme.

The diagrams in chalk, drawn from memory on the blackboard, often as a running accompaniment to a description, shared in the same admirable qualities as the spoken words. They were masterly performances, the cod's skull in particular was a triumph. Those who have watched this sketch growing, as bone was added to bone, until this complex structure stood revealed as a whole and in all its parts, will not soon forget the pleasure with which they watched this notable performance.

Facts, based on personal knowledge and organised into a natural system, were the basis of all Huxley's teaching; there was nothing *a priori*, and his powerful imagination, trained to its proper sphere, proved a faithful servant, never betraying him, as happens too often with lesser minds, by a treacherous domination.

This was eminently true of his treatment of evolution. The fact of evolution I think we took for granted, at

any rate we were abundantly supplied with the evidence on which it rests. The theory of evolution is another matter, but contrary to what seems to have been the experience of some of his critics, it was not shirked but fully expounded and illustrated. The exposition concluded with the statement that, *given* variation, heredity, and selection, then the Darwinian explanation affords a good working hypothesis.[1] But no attempt was made to account for what after all is the most fundamental of these factors, *i.e.* variation This still remains the crux

There was no zoological laboratory in those days, and consequently we saw less of our master than we desired, but a much-valued opportunity was afforded for conversation at the close of each lecture. On one of these occasions Huxley referred me for information to a German treatise, and on confessing that I could not read German, he spoke very impressively on the necessity of learning that language. At this I was very sorrowful, for after having suffered the drudgery of the classical method in an endeavour to learn the three languages which are usually inflicted upon boys at school, I had no desire for more. Huxley reassured me. "It is not so hard as it seems," he said "Don't bother much about the grammar to begin with, but go straight to the book you want to read, translate the first ten lines with the aid of a dictionary, and learn all the words Do this day by day and it will not be long before you will find to your surprise that you can read fluently and only need to use the dictionary now and then" I followed this advice and cannot be thankful enough for it. It has enabled me to add three or four other languages to my stock, and even to take a renewed interest in those of my school days. This was in 1869, and Huxley's plan is now, I believe, being advocated by influential teachers under the name of the "direct method." In how many ways Huxley was a reformer!

[1] Huxley was astonishingly open minded, and I have sometimes wondered what hypothesis he had in view when many years later he wrote that new ideas often begin as heresies to end as superstitions

The perfection of style by which Huxley's professorial lectures were distinguished was, I think, greatly owing to his singleness of aim, which was to assist us, so far as it was within his power, to a thorough knowledge of our subject. Consequently it was serious and simple, severely simple, only now and then, not often, relieved by a brilliant flash of humour which had about it a certain inevitableness and served to emphasise a point by its sudden illumination.

Thus, under a wise guidance, we traversed the whole of the animal kingdom, including man, taken not only as a type, but in all his manifold variety as manifested by the different races of mankind.

Huxley's delivery was sufficiently deliberate as to enable us—aided by occasional interruptions while diagrams were being drawn—to take down his words in full: my notes fill three bulky quarto volumes, to which, even after this lapse of time, I often turn for reference. The course extended over eighty-two lectures. I attended it twice, but much was changed in the second delivery; some subjects were more fully treated than before, others less, and much new matter was added embodying the results of the most recent research, much of it Huxley's own.

When I left London for Cambridge, and it was no longer possible to gather wisdom from the master's lips, instruction was still to be had from his published works, which followed in quick succession from his pen, and sometimes on memorable occasions even to listen, with a pleasure heightened by its rarity, to his well-remembered voice.

It was never my privilege to know Huxley as a friend, he was my teacher, that was all; with reverence and affection I worshipped from afar. Now as I look back over a long life I feel, while recognising how great is my debt to my many distinguished teachers, that I owe to him more, both morally and intellectually, than to any other I can name.

Truth and Righteousness.

By Stephen Paget.

It is, or lately was, the fashion, among the young writers of essays and journalistic paragraphs, to poke fun at the Victorian Age. This fashion came into vogue before the War, and, happily, it is going out, or will soon go. Those of us living who remember the glory and the magnificence of the Victorian Age are able without dishonesty or hypocrisy to think gently of its failures and imperfections, and to enjoy heartily the unending pageant of memory. Only, in that pleasant diversion, we find ourselves watching, now one group, now another, of the chief actors in the pageant. Above all, we find ourselves up against a question which is evaded by the young critics of the Age. What were the forces which went to the making of the Victorian Age?

A few years ago I set myself to try to understand the working of these concurrent forces. I wanted to discover the causes of the greatness of the Age, and the lines along which this greatness was ensured and established; and, as I read the written lives of the great Victorians, I perceived in them, as it were, a common endowment, the influences in later years of

a standard of purpose and ambition which had been set before them in the earlier years of home life It was the way with home life, fifty to seventy years ago, to be favourable to discipline and self-discipline : and, among the young men who were thus started on the right road, the young men of science came to the front. It was a period in which the fine arts were hindered by general admiration of prettiness, and by general distrust of anything excessive, or indecent, or extravagant. But in the kingdom of the natural sciences, where nothing is pretty, nothing improper, nothing artistic, the young men were free · for they were in their own kingdom.

They accepted the discipline of home . they put strict limits to their ambitions, desiring not to be rich or conspicuous, but to have enough to live on quietly in the service of science They set themselves to learn German . they kept themselves from the usual aberrations of thought among young men · and they took Carlyle as their guide and their prophet. Not one but many written lives testify to this upbringing and making of the men of science who were the glory of the Victorian Age They had the kingdom all to themselves · there were no women of science in those far back days But among these young men Huxley stands out . there is more in him than the early influences and circumstances of his life are sufficient to explain If it were possible to isolate one representative character in whom the Age is manifest now, that would be Huxley. For, as the Age unfolded its purposes, there came the longing of the men of science to educate the people Huxley is one of the foremost educators A lot of this education—Working-men's College, and that sort of thing—has now a rather antique look . yet the passion for the sharing of knowledge profoundly inspired the men of science, and not them alone, but they took the lead for, in the mind of the people, they had a message which none else could give. Especially, they had the message of evolution But Huxley's work for education went far deeper than that : and we are bound to remember what he did for the London School Board. He worshipped the advance of education : and his influence abides in all the present ways of popular education.

Huxley stands out, among the men of his time, as one of the chief of our prophets. Like all prophets, he had his share of resolute fighting for the truth. To him, a man's principal duty was to hold and defend the truth, and to let nothing in life come between him and it. We had in Huxley a perfect example of zeal in preaching : there never was a more faithful servant of the truth.

The noise of the fighting is over. The time is not yet come for any sort of attempt to estimate the loss and the gain of it all. Perhaps, a long way ahead, there will be historians able to judge the issues of man's study of man : but, as things are now, we seem far from any kind of settlement of the fight which began over the name of Darwin. Only, we must remember Huxley not only as a fighting man. Never did anybody set himself more strictly to self-examination and to self-judgment. He was keen to educate everybody, but he was most keen to educate himself. He plunged himself deep into philosophy, he got as far as men ever get in Descartes and Hume and many other authorities ; his Romanes Lecture was merely the final output of years of hard thought : it was welcome to quiet minds, and it was the utterance of a quiet mind

I wish that I could write of him as one of his pupils : I never came under the magic of his personal teaching. Merely, it was my good fortune as a son of Sir James Paget to see and hear many of the great Victorians, and, in the wonderful group of my father's friends, the vision of Huxley is very clear in my memory Certainly, nobody but a fool could be unconscious that he was in the presence of a man immeasurably superior to the run of mankind. I remember especially the wonderful look of his face in the later years ; the air of authority, the face showing signs of hardship and strain, the changing play of expression from gravity to laughter above all, the brilliancy of his eyes, the paleness of his face, and the tossed-back mane of white hair He was a lover of music : and I well remember, in my father's house, Lady Semon singing, and Huxley going down on his knee to kiss her hand in his gratitude for her song.

But what is the good of such memories, after all these years ? We are going back now a hundred years to the time of his birth we want something better than stray memories of him. That something better rests in the dominant idea of him as a great teacher and prophet, whose influence was extended over our country and over other countries. We have no such prophet now, not even in these days when our need of them is very urgent

All his life, Huxley cared only to tell the truth, the whole truth, and nothing but the truth : he could not bring himself to any acceptance of half-truths, compromises, superstitions, and all sorts of guess-work. This was the secret of his love of fighting so often as he came across a half-truth he had to hit it and perhaps he hit it with especial fury if it were supported by some very powerful champion, for instance, Bishop Wilberforce, or Mr. Gladstone But that is all over now : it was all involved in that adjustment of beliefs which made the Victorian Age not dull, as impatient young writers have been calling it, but supremely new and exciting. Anyhow, it was part and parcel of Huxley's preaching of the national need for truthfulness at all costs. Hereby he was a great prophet : and he was accepted far and wide as a prophet, accepted alike by learned men and unlearned But no adjustments of the opinions and faiths of mankind, after all, are bound to last for ever. Even Huxley, in the later years, was still holding himself open to all opportunities for the re-adjustment and rebalancing of his mind.

It might be possible, if here was the place for it, to mark a contrast between him and Ruskin, the other great prophet of the Victorian Age : and there is nobody like them now. But they stand far apart in the range of their interests. Besides, they did not make the same appeal to mankind ; moreover, there is the hard contrast between a man who had no family life, and a man who was devoted to family life.

The "Life and Letters" of Huxley, written by his son Leonard (Macmillan, 1900), give many pictures of the family life, and of Huxley's genius for friendship and for acts of generosity. Indeed, he cannot be isolated in our memories from his family and his friends. Yet our

first thought of him now is of a man who gave himself to endless work of teaching and of civilising. It seems a pity now that so little acknowledgment of his work came to him on any Honours lists; but the Order of Merit was not created in his time: still, there is a strange jump between him and a Privy Councillorship.

The beauty of his home life and of his character, and the magnificence of his work, his teaching, and his imaginative power over men can scarcely be put in print. He remains one of the leaders of thought in the past century: and we shall live to see new leaders of thought, but none with more power than was in him.

Huxley's Message to the Modern World.

By Prof. T. D A. Cockerell, University of Colorado.

AMONG the memories of the past, few are more vivid than that of the unveiling of the Darwin statue in the great hall of the Natural History Museum Addressing himself to the Prince of Wales and the Archbishop of Canterbury, representing the Trustees, Huxley uttered a message which in a manner summed up all his faith He did not ask for their official sanction of Darwin's views, no man's verdict could make those views true or false, justify or condemn them But Darwin's life, whatever the fate of his theories, must remain to us a glorious example, and future generations of students coming through yonder door might look on the image of his face and strive to follow his example

Although Huxley always insisted that the universe was one, not two, and poked gentle fun at those who pretended to find a justification for dualistic thought in the existence of two cerebral hemispheres, this little speech of his revealed a kind of inconsistency which we all admire He had no doubt that the operations of Nature followed a definite and consistent system, the workings of which were the subject-matter of scientific investigations. We were obliged to play our games, and must ascertain the rules to the best of our ability, for they would not be altered to please anyone. Eminent authorities might curse or bless, but the facts remained the same Yet of all men living in those days, few had a keener sense of human worth than Huxley. I do not think I misunderstood him when he seemed to imply that, after all, the moral grandeur of Darwin's life must remain, no matter what might prove true concerning his opinions. Michael Foster, who knew him so well, did not hesitate to declare: "Great as he felt science to be, he was well aware that science could never lay its hand, could never touch even with the tip of its finger, that dream with which our little life is rounded, and that unknown dream was a power as dominant over him as was the might of known science; he carried about with him every day that which he did not know as his guide of life no less to be minded than that which he did know" (Nature, Aug. 1, 1895, p. 320).

So Huxley lived in two worlds after all, but they were not separated in sharply defined compartments; they were as the warp and woof of the pattern of his intellect, inseparable and interdependent. What he said of Darwin we may well say of him, so that perhaps to-day his moral force is more valuable than his scientific contributions. The latter, at any rate, have been built into the structure of science, often as foundations now hidden by the building above. It becomes more and more difficult to discern exactly what his contributions were; they seem so much part of the body of knowledge that we can scarcely imagine the time when they were new. Thus the purely scientific Huxley tends to fade from view, while the moral Huxley, intensely human and full of strong emotions, is no more likely to be forgotten than St Francis. It is the latter aspect of his personality which now appeals to us, which strengthens our purposes and seems to point the way out of the perplexing confusion into which we have fallen.

When I try to imagine Huxley now among us, here in America, facing our present problems, I conceive that his counsel would be somewhat as follows: You cannot have successful democracy without moral sense, and that must show itself equally in tenderness of heart and honesty of purpose. It is not enough to mean well, you must do well, co-operating with the universe in which you live. The honest man faces the facts of existence and governs his conduct accordingly; he throws aside all sham and pretence, as soon as it is ascertained to be such. These are not mere pleasing generalities, but stern precepts in a land where ignorance is often enthroned, and masses of people pretend to believe that which in their hearts they know to be false. Power without wisdom, action without knowledge, must lead to catastrophe, no matter how excellent the political system, how worthy the traditions of the past.

Huxley himself would have put it better, but perhaps the meaning would have been about the same. Few there are, or have ever been, combining in one personality so many abilities: the keen intellect and the loving soul, the lively sense of humour and the power of wrath, the admirable expression and clarity of thought. But he of all men was the last to undervalue those of lesser breeds. He would bid us go forward with all courage confident of our ability to do something worth while. Probably he would stress, as he used to do, the importance of biology in education. There exists in the United States at the present time a strong movement supported by eminent educational authorities, practically to eliminate biology from High School education. In the larger cities the old High School course is being divided, the students of the first year being relegated to the newly established Junior High or Intermediate schools. Now it is widely proposed, with powerful supports, to offer biological subjects in the lower school, where they will be taught to very young students, but leave them out of the curriculum of the three years of High School proper. The result will be that pupils will graduate knowing little or nothing of biological theory, and having practically no real laboratory training. Administrators of schools will be saved a lot of expense in hiring well-trained teachers and purchasing apparatus. They will also avoid controversy over evolution and kindred matters. So insidious is this movement that few seem aware of it, but I think Huxley would be seen upon the heights, sounding the clarion of battle, were he here among us.

Personal Impressions.

By C. V. Boys, F.R.S.

AS I never took biology either as a student at the School of Mines or afterwards, it is only accident that ever brought me into contact with Huxley, and the occasions were few. They, however, have left a strong impression of appreciation of his kindness and of admiration.

On the first occasion I met him, so to speak, vicariously. As a student in the chemical laboratory I desired to see what the laboratory work upstairs was like, and I wandered up intending to see for myself. Huxley's demonstrator, Thomas Newton Parker, saw me, however, at once and explained very clearly that Huxley had no room in the laboratory for idle curiosity On the next occasion, in 1879, at Guthrie's suggestion, I told him about some curious observations I had made on a number of different species of spider as affected by a tuning-fork These interested him, and he recommended me to send an account of them to NATURE, where they were duly printed (December 16, 1880, vol. 23, p. 149). The Peckhams continued these observations in America.

Some years later I was offered a science mastership at a public school and Guthrie again suggested that I should ask Prof. Huxley for his advice. I found Huxley and Col. Donnelly, who was then director of the Science and Art Department, together, and they most kindly went into the question with that knowledge of the world which I could not possess, with the result that I remained at South Kensington, and for this I am grateful.

Huxley's powers of exposition were amazing That same curiosity, I hope not too idle, prompted me to attend one of his class lectures when I was a student I think the subject was the internal economy of the cockroach, which as a subject did not interest me, but his clear exposition and his facility with chalk and the blackboard left a lasting impression. On a later occasion I attended his Friday evening discourse at the Royal Institution on "The Coming of Age of the Origin of Species" His almost painfully slow delivery —every word clear and carefully prepared—held the audience in rapt attention, and I remember well the expression in his peroration—more aggressive at that time than it would be to-day—"Man and other Animals."

A Student's Reminiscences.

By Rev E. F. Russell.

IT was in the year 1875 that I, a curate of a London parish—S. Alban's, Holborn—was bold enough to introduce myself to Prof. Huxley. I had not been invited by him, or commended to him, nor had I any sort of claim upon the time and attention of so famous and so busy a man I simply made a venture and knocked at the door of his private room on the top floor of the Science Schools, South Kensington. He was writing what seemed to be the minutes of a society meeting, of which he was secretary. Whatever he may have felt of annoyance at the intrusion and interruption of a stranger at so inconvenient a moment, he showed no trace of it in his manner, but simply asked my business. I told him that I had read and had been impressed by his remonstrance with the clergy who had denounced his teaching without having made themselves acquainted with even the first principles of the science upon which his teaching was based. Not that I myself had been guilty of that particular kind of folly, but I was conscious of an ignorance as complete as theirs, and was at a loss how to get at the knowledge that I lacked, not finding much that served my purpose in the text-books of the time. It was this sense of my ignorance that drove me to him for help. He treated me and my appeal with perfect courtesy, offered me a chair and a cigar, and proceeded to give me an outline of the course of instruction which he was just about to commence. The course lasted several weeks, and included a daily lecture, followed by some hours of practical work on the subject of the lecture in his laboratory.

This seemed exactly what I was looking for, and I closed at once with the suggestion that I should join the class. I remember having some misgivings as to how my fellow-students might regard the presence of a clergyman in their lecture-room. If this now sounds absurd, it should be said that I was at that time visiting a clergyman friend who was a prisoner in Horsemonger Gaol for conscience' sake! My fears were quite groundless. I was not the only clergyman attending the lectures, for my neighbour in the laboratory was a Jesuit professor from the University of Louvain. It was known that we were both eager to learn and that was passport enough. As much could not, however, be said of all who attended the lectures, for some were there not because they loved the subject, but because they had to secure a certificate of attendance to qualify for some teaching appointment

In spite of this, Prof. Huxley gave us of his very best. It was not a repetition of the last year's lecture, for he varied his course from year to year Each lecture was a new lecture, freshly prepared for, not only by studies in the current biological literature, but also by laborious work in dissection and research. We students felt him to be the most enthusiastic student of us all. The order of our daily round was this. Each morning whilst the clock was striking ten—he was never late—the door from the professor's private room into the lecture-room opened and he passed swiftly to his platform. Without preface he took up at once his subject where he had left it the day before, and kept strictly to it without digression

Half a century has passed since I listened to those lectures, and more than four score years of use have made some holes in the purse of my not very retentive memory; but my remembrance of the scene, of the voice and manner of the lecturer, of his keen and strong personality, is as fresh and vivid as if it were of yesterday. I recall it all as one might a voyage of discovery, full of wonder and delight. Since then

I have heard many admirable lecturers, but never another who was quite his equal in the affluence of his ready knowledge, in his power of apt illustration, in his ability to help us visualise what he described, in his command of pure English speech. At times, but not often, he lit up his subject by the summer-lightning of his humour. He was an expert draughtsman and turned his skill to account constantly on the black-board It was interesting to watch him draw. He used coloured chalks, shading his drawing in parts with his finger and giving them a quality which made them not only instructive but easy to remember I had expected that there would have been, on occasion, some reference to the current controversies with which Prof. Huxley was identified, but nothing of the kind happened, and the ultimate result of his words and influence, far from unsettling my beliefs, was to leave with me a new and delightful sense of the greater wonder, wisdom, power, and beauty of Creation by evolution than by an act sudden and complete

After the lecture we passed on into the adjoining laboratory, where each one of us had his assigned table fitted with its microscope and other apparatus and instruments required On our table each day a specimen of the subject dealt with in the lecture was placed, awaiting our study and dissection The supply of specimens was ample and well chosen, like all else of the well-considered and generous equipment of the laboratory. On the walls were many beautiful coloured diagrams, the work of Mr. G. B. Howes, who later succeeded Prof. Huxley as professor of biology. A small working museum was close by, which contained elaborate dissections preserved in spirit, and models of various organisms in successive stages of their development. Our demonstrator was no less a person than Mr. T. J. Parker, afterwards professor of biology at Otago, and a writer of authoritative books. Occasionally Prof Huxley himself paid us a welcome visit and, glass in eye, examined and commented upon what we were doing. Even the laboratory "man" was an expert anatomist. He once set up for me the disarticulated skull of a cod-fish, and did the difficult task so well that the skull found a place in the Museum of St Bartholomew's Hospital, Smithfield.

When, like Marcus Aurelius, in the evening of my life I look back upon past years and count up the names and benefactions of those to whom I owe so much, I find myself dwelling with especial gratitude upon the name of Thomas Henry Huxley, what he was and what he did, for from him I learned, so far as I was capable of learning, not only the principles of biology, and of the scientific method, but also, from his example, such high qualities as the habit of observation, accurate and intense, of patience and thoroughness in all we undertook, and—I would add—of courtesy to strangers.

The Huxley Memorial Lecture and Medal of the Royal Anthropological Institute.

IT is especially incumbent upon anthropologists to preserve the memory of Huxley; for he did more than any other scientific thinker of the nineteenth century to remove misconceptions as to the aim of the science and to combat the prejudice with which it was regarded in the early days of its development. The Royal Anthropological Institute, however, is peculiarly indebted to him, for he was in a sense its founder. It was largely due to his tact and powers of conciliation when, as president of the Ethnological Society, he was carrying on negotiations with representatives of the Anthropological Society, that the differences of the two societies were composed, and an amalgamation followed which led to the foundation of the Institute in 1870.

At Huxley's death in 1895 it was the desire of the Council of the Anthropological Institute that Huxley's great services to anthropology should be specially recognised. A chair of anthropology had just been founded in the University of Oxford, to which E. B. Tylor had been appointed. It was felt that a Huxley professorship at one of the other universities would most appropriately perpetuate the memory of this side of his work. The suggestion was submitted to the Huxley Memorial Committee and received the support of Sir W. H. Flower; but it was not adopted. It was thereupon decided by the Council to supplement the objects selected by the Committee from among the many suggestions submitted to them, by the institution of a memorial lecture to be delivered annually by a distinguished anthropologist, to whom a Huxley Memorial Medal should be awarded. By an agreement with the Memorial Committee, permission was granted for the use for this purpose of the die of the obverse of the Huxley Memorial Medal of the Royal College of Science which bears the portrait of Huxley.

The Huxley Memorial Medal of the Royal Anthropological Institute has come to be regarded as the highest award in Great Britain open to an anthropologist. The first award, appropriately enough, was to Lord Avebury, long Huxley's intimate friend, who delivered the first Huxley Memorial Lecture on November 13, 1900, taking as his subject, "Huxley, the Man and his Work" (see NATURE, vol. 63, pp. 92 and 116). The medal has since been awarded to a succession of distinguished anthropologists, both British and foreign, whose memorial lectures, while dealing with their subjects on broad lines in accordance with the terms of the foundation, have been, as a rule, at the same time of some considerable importance as contributions to anthropological science. Among those whose names appear in the list of medallists may be mentioned: Sir Francis Galton, Prof. D. J. Cunningham, Sir Edward Tylor, Dr. J. Beddoe, Sir Flinders Petrie, Sir W. Boyd Dawkins, Sir James Frazer, Sir Arthur Keith, Dr. W. Z. Ripley, Dr. J. Deniker, Dr. F. von Luschan, Dr. Gustav Retzius, Dr. E. Cartailhac, Prof. M. Boule, Dr. E. S. Hartland, Dr. A. C. Haddon, Prof. W. J. Sollas, and Mr. Henry Balfour.

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh*



SATURDAY, MAY 16, 1925.

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Editorial and Publishing Offices.
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2898, VOL. 115]

Science and Administration in East Africa.[1]

THE special geographical difficulties of tropical East Africa due to climate, remoteness, and the scantiness of the native population, have led to an awkward dilemma as to the labour and land policies. In consequence, serious friction arose between the European and Asiatic settlers and the Government, and widespread unrest among the natives. Accordingly, the late Government appointed a Commission consisting of the Hon. W. G. A. Ormsby-Gore (the present Under-Secretary for the Colonies), Major A. G. Church, then a Labour M.P. and secretary of the National Union of Scientific Workers, and Mr. F. C. Linfield, then a Liberal M.P., to collect information and report on the development of the British East African Dependencies, and on the social and economic conditions of the natives. The Commission, after a long tour of inspection, has prepared a valuable report on the countries and their administration. One of its most gratifying features is its recognition of the economic value to such countries of scientific guidance, and this welcome innovation enhances regret at the deplorable contrast described between the former attitudes of the British and German Colonial Governments towards scientific research.

Before the War, German East Africa was described in monumental scientific works which have taken their place amongst the standard contributions to the literature of tropical Africa, and several well-equipped scientific laboratories had been established. Mr. Ormsby-Gore and Major Church visited the Amani Institute, which was founded by the German Government in 1902. Its extensive grounds range from 1300 to 3600 ft. above sea level, with a branch establishment at sea level. The Commissioners report that the German Government spent 120,000*l.* on the station, they consider that it was superior to any corresponding institution in any British Colony, and compare it with Buitenzorg in Java. In its extensive grounds vast plantations of tropical shrubs and trees of economic importance were established, the laboratories investigated plant diseases and breeding, and analysed the soils; and the lectures of the expert staff and the publications explained its results to the colonists.

The War stopped all this useful work. The British Government in 1920 placed the Institute under the Agricultural Department of Tanganyika Territory. Sir David Prain, who reported on it in the same year,

[1] (*a*) Report of the East African Commission. (Cmd. 2387.) Pp. 195. (London: H.M. Stationery Office, 1925.) 3*s.* 6*d.* net.
(*b*) Education in East Africa: a Study of East, Central, and South Africa by the Second African Education Commission under the Auspices of the Phelps-Stokes Fund, in co-operation with the International Education Board. Report prepared by Dr. Thomas Jesse Jones. Pp. xxviii+416+44 plates. (New York: Phelps-Stokes Fund; London: Edinburgh House Press, n.d.) 7*s.* 6*d.* net.

urged that the Director should be independent of any Department and responsible directly to the Governor, and urged its development as a central research institute for the British East African Dependencies. Their Governors were asked by the Colonial Secretary for financial support. Two of the five Dependencies were unable to contribute at the time, and the Institute remained under the Agricultural Department—with the results foreseen by Sir David Prain. Last year the Governor of Tanganyika recommended that the Institute should be closed, the Director resigned, and several thousand acres of adjacent land were announced for sale. The intervention of Mr Thomas saved the Institute from this fate, and has given it another chance The Commission strongly urges that a fresh attempt be made to maintain it by securing financial support from the five Dependencies, a substantial grant from the Imperial Government, and a suitable constitution If these recommendations be carried out and Amani developed on the lines recommended by Sir David Prain, it should do for East Africa what Pusa is doing for India. It should be supplemented by local laboratories. Not only, however, was Kenya Colony unable to contribute to Amani, but its own institutes, the Naviasha Stock Farm, the experimental farm at Kabete, and the station at Mazeras were closed in 1922–23 on financial grounds—a "most unfortunate" step, say the Commissioners.

Amani should serve the main purposes of East Africa for forestry and economic botany. The Mpapwa Research Laboratory, also a German foundation, may similarly serve as the central institute for work on stock and their diseases, and the manufacture of serum; but so little is known in one East African colony of the progress in the next that the Commissioners were assured in Northern Rhodesia that the Mpapwa Institute was derelict, and they state that its results are unknown in Kenya Colony.

The Commission strongly recommends the extension of the geological surveys, and directs attention to the valuable results obtained by Dr. Dixey in Nyasaland and Mr. Wayland in Uganda Tanganyika and Kenya Colony have neither of them at present a geological survey; in one case owing to action by the local government, and in the other by the Colonial Office. The Commission regrets the decision that the Nyasa Survey is to be suspended unless some profitable mineral be soon discovered This policy seems particularly deplorable in regard to Nyasaland, which, in spite of its many advantages, remains the poorest of the East African colonies owing to the difficulty of communication with its port. As the Commission points out, a geological survey is not merely of value in discovering ores: its main service is in the preparation of a geological map which will help many departments of work as a guide to the distribution of the various types of soil, of underground water, and of such materials as clays, building stones, cements, limestones, and road metals, and in reference to public health Local supplies of these heavy low-priced minerals are of high value in a remote country, and are indispensable to many industries. A new country has not the benefit of the experience of centuries of local observation to indicate where these materials can be found. They must be discovered by a scientifically conducted search. The maps of a geological survey in a newly settled country may repay their cost by avoiding waste in industrial and agricultural development The Commission, it may be remarked, quotes Dr Dixey, Government Geologist of Nyasaland, that water diviners, faith in whom is widespread in East Africa, and water-finding machines, are completely valueless.

The Commission strongly recommends the development of the Nairobi Museum, which was founded by the Uganda and East Africa Natural History Society. It has been suggested that this Museum should be extended as a memorial to the late Sir Robert Coryndon, and it is to be hoped that this scheme will be adopted.

Mr. Ormsby-Gore and his colleagues recognise that more funds should be provided for scientific work, and they urge the extension of the power and activities of the Colonial Research Committee It was intended to have at its disposal 20,000*l* per annum for five years; but its grant was cut down by the Geddes Committee to 2000*l*, which, as the Commission remarks, is quite inadequate. "There can be no doubt," says the Commission, "that increased provision under this head is one of the chief methods whereby Great Britain can assist her tropical possessions and her own trade. But, above all, it is essential that greater encouragement and better pay should be given to scientific officers in order that a supply of trained men shall be forthcoming from the Universities"

The East African Commission has directed attention to the urgent need for Government co-operation in education. On this subject its proposals are endorsed by the recommendation of the Phelp-Stokes Commission, the chairman of which, Dr. Jesse Jones, is an expert on Negro education in America. This Commission was accompanied by Dr. Shantz, of the United States Bureau of Agriculture, who has prepared an instructive report on his observations. The Phelp-Stokes and Ormsby-Gore Commissions coincide in their chief educational views. They both express high appreciation of the missionaries' educational work, but recommend that it should be subject to Government inspection. The Ormsby-Gore Commission states

that if the missionaries knew what was being taught by some of the native teachers at the "so-called mission schools" they would stand aghast.

Mr. Ormsby-Gore's report includes several educational proposals which will be received with warm approval. In reference to one much-debated problem the Commission approves of elementary teaching in the language of the locality, and that where a second language can be taught it should be English. It also shows its practical insight by the recommendation, "We attach great importance to making natural science, as far as possible, the basis of higher education in African native schools." A knowledge of the three R's is, of course, essential, but they should be used for teaching the elements of natural science as illustrated by the life, agriculture, sanitation, and physical geography of the country in which the pupils live

Mr. Ormsby-Gore's position as Under-Secretary of State for the Colonies should secure the adoption of his Commission's proposals. They would lead to a great advance in scientific research in East Africa, and help to remedy the various ills he and his colleagues were sent to investigate. J. W GREGORY.

The Herring.

(1) *Meddelelser fra Kommissionen for Havundersogelser* Serie: Fiskeri. Bind VII: On the Summer- and Autumn-Spawning Herrings of the North Sea. By Dr. A. C. Johansen. Pp. 118 (Kobenhavn: C. A. Reitzel Boghandel, 1924.)

(2) *Ministry of Agriculture and Fisheries Fishery Investigations.* Series 2, vol. 7, No. 4, 1924. First Report on Young Herring in the Southern North Sea and English Channel Part I.: Distribution and Growth of Larval and Post-larval Stages, by Dr. William Wallace; with Appendix: The Water Movements of the North Sea in relation to the Geographical Distribution of Post-larval Herring, by J. N. Carruthers. Pp. 84. (London: H.M. Stationery Office, 1924.) 13*s.* net.

(3) *Ministry of Agriculture and Fisheries. Fishery Investigations.* Series 2, vol. 7, No. 3, 1924: The Herring in Relation to its Animate Environment. Part I.: The Food and Feeding Habits of the Herring with Special Reference to the East Coast of England. By A. C. Hardy. Pp. 53. (London: H.M. Stationery Office, 1924.) 8*s.* 6*d.* net.

THE herring is our most important food fish. Workers in different countries are approaching the problems connected with it from different points of view. The accumulation of data tends towards both simplification and complication. It is possible that increased hydrographic knowledge may assist us to foretell, to some extent, the nature of the fishery and that applied science may score a success, but the understanding of the subject is in the realms of pure science. The three papers specified above all help, in varying extent, to increase our knowledge.

(1) Dr. Johansen's work is a contribution to our knowledge of the racial characters of herring, and deals with, chiefly, the summer and autumn spawners of the North Sea. The numbers of vertebræ, keeled scales between the pelvic fins and anus, and rays in the pelvic, dorsal, and anal fins are treated statistically. Use is made of the results obtained by other workers We have a comprehensive work which enables us to take a broad view of the subject of herring races

The summer herrings of the east coast of Scotland, the Dogger Bank, the Jutland Bank herrings, and part of the Shetland summer herrings are all referred to one race, the Bank herrings of the North Sea. The main spawning-grounds of the race are near the British coast, from the Shetlands to Norfolk, and in the vicinity of the Dogger Bank. Spawning occurs also on the Little Fisher Bank and the Jutland Bank, including the adjacent waters of the Skager-Rack. It is indicated, however, that the Jutland Bank herrings have not been investigated sufficiently and that there are differences between the Scottish and Dogger Bank herrings.

In the attempt in Chap. x to connect the racial characters of the Bank herring with temperature and salinity at the spawning-places, and compare the spawning of this race with that of the North Sea Deep-water herring and the Autumn herring of the German Bight, a great deal is assumed. The differences between the Bank herring and those from the deep water and German Bight are small. Comparison is made with herrings caught in the Kattegat, the Channel, northern waters, and the spring spawners of Scottish waters.

Following the general survey of shoals from waters adjacent to those yielding the Bank herring, an examination of the herrings of the Skager-Rack and Kattegat is given. The catches made from these waters show considerable fluctuations which have conveyed the impression that the fishery from about the entrance of the Baltic was one due to migrations. Johansen's work supports this idea and shows that, whilst Kattegat and Norwegian herrings are caught, the most important herring in these waters is the same as is found in the North Sea. This naturally leads to a consideration of Pettersson's work on periodicity in the fishery and, to a less extent, on the effect of currents, temperature, and salinity on migrations As is pointed out by Johansen; there are two extreme views held with regard to migrations. One is that the herring is always a wanderer and has no fixed spawning-ground, and the

other is that herrings when they become mature return to where they were hatched

It is highly possible that some herrings do return to the place of their origin, and there is much evidence which can be taken as indicating that spawning shoals return to the same spawning-grounds year after year, but there are indications that herrings spawn independently of when and where they were hatched. New spawning-grounds are formed; fisheries have been known to disappear, a change in the number of spawning fish on the grounds may appear, as has been the case recently in the East Anglian fishery, changes in extent and direction of migrations have been indicated, and whilst it is possible, for convenience, to think of spring and autumn spawners, it is also possible to have spawning taking place in eleven months in the year, in the North Sea or waters adjacent. Further, the young are carried by the prevailing currents, they grow at different rates; there is evidence which points to shoaling being governed by size in immature shoals and by development in spawning shoals, and we have the fact that variations in development are great: young fish with two winter rings may be taken spawning, whilst virgins have been taken with as many as six winter rings.

It is a combination of all these which makes it difficult to think that the differences shown by Johansen are correctly defined by being named racial. There is a difference between herrings from different waters. It is one which can be expressed generally in terms of size for age, and the rate of growth decreases as oceanic conditions give place to those of narrow waters. There is evidence that a migration from narrow waters to oceanic conditions is followed by a great increase in the rate of growth

If we arrange the data given by Johansen according to oceanic and narrow-water conditions, we find a gradual decrease in the number of vertebræ and an increase in the number of keeled scales We have therefore much the same change as has been found for rate of growth. It is possible that the "racial" differences are such as could be produced in a generation by environment. The work of Schmidt, a short account of which is given, pp. 89-90, can be taken as supporting this view.

It is of interest that the high number of vertebræ found in spring spawners of the Firth of Forth supports the conclusion, arrived at from a consideration of the rate of growth, that some of these fish migrate south for spawning.

Whilst it is impossible to agree with the conclusions of Johansen as to the different races of herring, it is equally impossible not to have a high appreciation of the work he has produced. It is a very welcome work and one which must be considered seriously by every one connected with herring investigations.

(2) This paper deals with the larval and post-larval stages, collected by the Ministry of Agriculture's research vessel, and those of Plymouth and Belgium, in 1921–1923 The material has been analysed by Dr. Wallace and helpers, and Mr. Carruthers has furnished hydrographic data which add considerably to the value of the work. Detailed accounts of the various cruises, the catches made, as well as a consideration of the hydrographic conditions, yield information which increases our knowledge of the drift of the young and also of the rate of growth The work is well illustrated with charts and diagrams.

The area investigated was of considerable extent, and stretched from the Northumberland to the Cornish coast It is to be regretted that, as the Dogger Bank area was not surveyed for spawning-grounds, records for comparative purposes in future years are not available The high numbers of recently hatched fish found in the Southern Bight and the eastern end of the Channel make it desirable that the investigations do not come to an end before it is established, whether or no, spawning to such an extent as indicated can be considered a general condition.

The drift of the young brings about, in the Southern Bight, and to some extent in the German Bight, a mixing of autumn-spawned young of the North Sea with the winter-spawned young from the Channel. From the data supplied by Carruthers it is evident that the drift of the larvæ varies; and Wallace directs attention to the difficulty of assigning fry caught in the Southern Bight to either the Dogger Bank or the Channel race of herring.

This work should be read in conjunction with that of Dr. Johansen. No other paper, to the present writer's knowledge, has shown so well to what an extent the young from different spawning-grounds can be mixed, and, from the supporters of herring races, it calls for an explanation as to how and when the races sort themselves again

(3) Most of the data in Mr Hardy's paper are for southern North Sea fish, though young stages from the eastern portion of the Channel have been examined. The results of previous workers are given.

The food of the young consisted chiefly of diatoms and peridinians. With increased size there is a change in the food; larger plankton forms are taken and the smaller of the common copepods become of importance. After metamorphosis the range of food is increased, and it varies from the largest plankton forms to the eggs of shrimps and crabs. It is difficult to imagine how the latter can be of much importance. Their presence and the other foods found in the stomach point to the

herring taking practically anything which is floating in its vicinity. This makes doubtful Hardy's suggestion that varying numbers of Pseudocalanus in the southern part of the North Sea may be the cause of fluctuations in later years.

The food consists of plankton, and there is evidence that in spring the larger forms are selected The presence of recovered spents may have influenced the curve given by Hardy, on p 17, representing the feeding of the herring, which shows an interesting agreement with Lea's curve representing the growth of Norwegian herring.

A portion of the paper is devoted to various opinions as to how the herring takes its food From the stomach contents and observations at Cullercoats, Hardy is of the opinion that feeding is selective and carried out by a definite act of capture.

Such diagrams as Fig 11, or models in three dimensions as Hardy suggests, have their value and call for some ingenuity in their making, but it is doubtful if they are necessary The price of the Ministry's reports is so great that only those interested in the subject are likely to buy. The majority of workers on fishery problems should be able to picture the results without such aids.

It may be that *Limacina retroversa* is a regular constituent of the plankton off the Northumberland coast in late summer, but we must have other reasons than a statement of belief before this can be accepted

B. STORROW

Chemistry and Technology of Cotton-Cellulose.

Cotton-Cellulose: its Chemistry and Technology By A. J. Hall. Pp. 228. (London: Ernest Benn, Ltd., 1924) 30s. net.

WITH the establishment of the Linen and Cotton Industries Research Associations in England, and such institutes as the Kaiser-Wilhelm Institut fur Faserstoffchemie in Germany, the number of "cellulose chemists" has increased considerably during the past few years, and many questions which have for too long been in doubt are beginning to show some prospect of solution. Indeed, so rapid are the advances in knowledge, that to workers actually engaged in this field a text-book has but little interest. There are, however, many reasons why a book should be written on cotton for the non-specialist scientific worker; first, to remove an impression that cellulose is a dull, inactive material only interesting in its technical applications, and secondly, to explain why those who do decide to experiment with it should supply precise information as to the origin of their material and the conditions of their tests when recording results

Mr Hall has written such a book, but unfortunately he has begun too soon. The novel sections of his book are those in which he summarises, with little attempt at criticism, the newest results published in Great Britain, but we venture to suggest that as most of the work reviewed is mainly exploratory, a much more interesting story will be told in a few years' time It should then be possible to write of discovered broad principles, rather than merely to record copious details of miscellaneous experiments Furthermore, the author has not quite succeeded in quickening the imagination; true, he does show that cellulose is abundantly reactive, but not in such a way as to attract new workers with its possibilities for research. Nor does he succeed, except to those who already know, in emphasising the variability of cotton, and the difficulty of obtaining "cellulose" from it, free from mineral and other impurities but unaltered in physical and chemical properties The method of the Cellulose Division of the American Chemical Society (p 40) is probably too precise in specifying "Wannamaker's Cleveland cotton" as the source of "standard cellulose," but some explanation of the intentions behind this exactitude, on one hand, and, on the other, of the danger of regarding any promiscuous sample of surgical cotton-wool as "cellulose," should have been given.

The first chapter deals with the development, morphology, and physical properties of the cotton hair. Unimportant details are recorded about the convolutions which so strikingly distinguish cotton, but the most absorbing question—by what mechanism are they formed—is not discussed The next chapter treats of the non-cellulosic materials in raw cotton and their removal. The use of enzymes and acids in bleaching should have received more notice, and the work on solvent extraction described later on (pp 109-126) and the properties of "steam distillates" of cotton (p. 139) might well have come in this chapter. The interesting fact that Egyptian cotton contains more phosphorus and nitrogen than American, even when grown in the same environment, may be compared with a recent discovery that the sap in the Egyptian plant is richer in mineral salts

The author next proceeds to deal with the action of alkalis on cotton. Surely water should have come first. The moisture content of cotton and its variation with humidity and temperature are so important in all processes from spinning to dyeing and calico-printing, and also in testing and storing, that more might have been written than the notes on pp. 79 and 137-139.

The chapter on the action of alkalis is one of the best in the book. It seems to be true that a curve connecting

concentration of alkali solution with the quantity of alkali removed from it by cotton shows a few steps corresponding with definite compounds of cellulose and alkali, but the curves connecting dimensional changes in the cotton hair with alkali concentration are much more difficult to interpret. How far this is due to the presence of a tenacious "cuticle" remains to be seen, but it is possible that some of the published curves need confirmation. It would have interested the general reader to be told the five or six different objects of "mercerisation." The statement at the head of p. 81 that "no adequate explanation of the increased absorptive power of mercerised cotton has been put forward" already needs modifying. The recent work of Katz on the X-ray analysis of mercerised fibres is most suggestive.

Chap. iv., on the action of acids, is good, but Chap. v. is a medley dealing with viscose, and the effects of mechanical stresses, heat, salt solutions, organic solvents, light, ammoniacal copper hydroxide solutions, water, moulds, and bacteria. In a new edition this will require complete revision, particularly as many new facts are already available. Some figures on the amounts of various solvents and salt solutions which a given mass of cotton can soak up might have been recorded, they are frequently demanded, but are not readily accessible.

The action of oxidising agents on cotton is the subject of Chap. vi., which is a sufficient summary of much conflicting material. Scarcely anything better has been written on "Oxycellulose" than Witz's original communications of nearly 120 pages in the *Bulletin de la Société industrielle de Rouen*, 1882-1883, and it is a calamity that only abstracts of this paper have been available except at one or two libraries in the whole of England. A weakness of the chapter is that it does not sufficiently indicate how cotton may suffer oxidising attack in practice, and how this affects its mechanical and dyeing properties

Chap. vii., "Cellulose and Dyes," deals overmuch with dyes, giving unnecessary graphic formulæ, and not enough with dyeing. Scarcely anything is said, for example, on the factors affecting the penetration of cotton, and more might have been made of the theories of dyeing. Chap. viii., on the constitution of cellulose, has received the oversight of Sir James Irvine himself, and is an adequate summary of the contributions of organic chemists. There should have been some mention, however, of the X-ray work done in Germany.

Artificial silks form the main subject of Chap. ix. An adequate book on this subject is long overdue in English; for the present purpose, the chapter is no doubt sufficient. The final chapter gives some select methods for the estimation of nitrogen, phosphorus, waxes and their characteristics, the "copper number," etc., of cotton. It was unnecessary to illustrate a pill press for cotton plugs (p. 221) and the space might have been given to some cross sections of various types of cotton and artificial silks.

The book is written in good style (except "this data is"), but a protest must be made against the constant use of "strength" of solution for "concentration" and "breaking strain" for "breaking load." The printing and illustrations are excellent though the tables are generally set too large. On pp. 76-77, for example, the story is broken into five times by small tables, and frequently much space is utilised to tabulate no more than two data. This makes the book less pleasant to read.

Whilst suggesting, therefore, that the book is not what one hopes to see written about cotton in a few years' time, the reviewer is justified in saying that a better summary of the knowledge available at the middle of 1924 does not exist Mr. Hall is to be congratulated on his praiseworthy, though premature, attempt to reduce a colossal literature to its essentials in a readable manner.

J. C. WITHERS.

Seventeenth-Century Science.

Early Science in Oxford. By R. T. Gunther. Vol. 4: The Philosophical Society Pp. viii + 259 + 4 plates. (Oxford: The Author, Magdalen College, 1925.) n.p.

THERE are still to be met scientists who display impatience at the *haec olim's* of their own antiquarians, and regard the science of the seventeenth century and that of the twentieth as two provinces totally distinct. But on many hands a more understanding survey of those distant realms is growing; and those who find pleasure in the methods of science as well as in its results are nowadays in the position of that Dr Smith who (p. 22)

"has undertaken to procure a new Chart, made by a Gentleman who has lately travell'd from Muscovy to China; by this Chart it appears, that those two Countries are not so far distant from one another, as our Maps commonly make them."

Mr. Gunther fills the valued rôle of one of the chart-makers, whose labours are bringing to light the near apposition of the seventeenth and the twentieth centuries in the basic methods of science; and indeed, the two are alike in more than method.

Let us see what is to be extracted from his latest publication, which appeared opportunely for the proceedings at the Old Ashmolean Building, described in NATURE of May 2 (p. 651). Nearly the whole of the book consists of the Transactions of the Philosophical Society of Oxford (1683–1690), transcribed *literatim*,

These have been accessible hitherto only in the original Ashmolean manuscript and in a copy made about eighty-five years ago for the library of the Royal Society. The selections from these records which have been appearing recently in NATURE well illustrate their matter, and make quotation here unnecessary; but in this book Mr. Gunther has annotated them with explanations, citations, and cross-references, and the whole is most useful to the student. These notes, and the re-edited Index, must be the product of a very great deal of labour, coupled with an acquaintance with the relevant sources such as probably no one but Mr. Gunther can compass, and the reader will not fail to acknowledge the authority which these editorial notes too modestly attest.

Mr. Gunther has prefixed an introduction of sixteen pages, reviewing the establishment of the Society, and exhibiting its near concern with the early Royal Society. The Transactions of the Oxford assembly refer, of course, to a period twenty to thirty years after the founding of the Royal Society, towards which by this time it stood in the relation of an adopted daughter and handmaid. There is, indeed, room for doubt concerning the continuity of the Oxford Philosophical Society after 1651, near which date it was founded for the first time—whether under its later name or not—by the distinguished men who had had the still earlier "Invisible College" in London. In the 'fifties it was really a non-corporate cluster of brilliant workers, who were thereafter drawn for their organised scientific intercourse to Gresham College in London, where they founded the Royal Society. By 1683, however, a fresh generation of virtuosos had arisen at Oxford, with the grave old mathematician Wallis and the buoyantly inquisitive Dr. Plot as their mainstays, so that it became worth while to found the society anew; and it is at this stage that the doings portrayed by Mr. Gunther begin.

At a casual inspection, the spirit informing these doings is reminiscent of nothing so much as that of a private museum collected by Huckleberry Finn: excepting when it is in the vein of a solemn crank in a club—"what Creature makes ye greatest noise in proportion to its bigness? Probably 'tis ye *Teredo*." Such a comparison is unfair to many truly weighty contributions; but there is a measure of real truth in the attribution of a boyish love of oddities. For it was a time when an altogether new set of fairy tales had been made possible to read, in the shape of natural lore; and these charming amateurs were eagerly reading them for the delight of marvels newly revealed. For us, their tales have become old-fashioned, if we look merely at the facts told in them; but we still, like Huck and the old Oxford scientists, are lucky enough to have the boyish hope of new surprises; and it is to the seedling which men like them fostered, and which is fructifying so fast in the twentieth century, that we owe our gratification of that hope to-day. In two or three centuries hence, our own present delight in quanta, protons, or vitamins will doubtless be looked upon as pleasantly ingenuous and even amusing; but these things will have been no more and no less necessary to the science of posterity than are the *Quaere's* and discoveries of the seventeenth century to ours, for their purpose was our own and we derive it from them. Let us therefore "praise famous men and our fathers who begat us." IRVINE MASSON.

Our Bookshelf.

The Mammals of South Australia. By Dr. Frederic Wood Jones. Part 2: Containing the Bandicoots and the Herbivorous Marsupials (the Syndactylous Didelphia). (Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch) and published by favour of the Honourable the Premier). Pp. ii + 133-270. (Adelaide: R. E. E. Rogers, 1924) 4s.

WITH the appearance of the second part of his review of the mammals of South Australia, Prof. Wood Jones completes the account of the monotremes and marsupials. It is at once the most exhaustive and comprehensive guide to these two groups that has yet appeared, and is distinguished for its originality of treatment, for the vast amount of most interesting observations on the habits of these animals based on an intensive field experience, and for the large series of clearly reproduced illustrations from original drawings which serve to elucidate the text

Prof. Jones is revolutionary in his conclusions on the problems which are connected with the marsupials as a whole. He rejects the division of the group on tooth characters in favour of one based on the characters of the pes, and classifies them into Didactyla and Syndactyla. The former have retained their primitive polyprotodont condition, while the latter have become further differentiated into those retaining the primitive dentition (polyprotodont) and those in which the dentition has become specialised (diprotodont). This classification is based on the grounds that the syndactylous condition is not the result of degeneration, but of a specialisation resulting in a highly organised anatomical mechanism for combing the hair. As such it is more likely to have arisen only once in evolution than to have become developed independently in two different phylogenetic races. There are, moreover, no didactylous diprotodonts. In this view of the phylogeny of the group the author follows Bensley, and is in opposition to the generally accepted arrangement. The argument is put forward with considerable force and, it must be said, with conviction. Prof. Jones's contention, too, that the marsupials reached Australia from the north, *via* Malay, is equally cogent, and deserves at least the considered attention of those who favour the alternative and generally accepted view of their immigration from South America.

Palgrave's Dictionary of Political Economy. Edited by Henry Higgs. New edition. Vol 1: A-E. Pp. xviii+924. (London: Macmillan and Co., Ltd., 1925.) 36*s* net.

THOUGH this is the first volume of Palgrave's standard work, it is the second of the new edition to appear, and students of economics will have reason to be grateful to the publishers for furnishing them with so excellent a reprint of an extremely useful book The plan of vol. 1 is precisely the same as that of vol 2, which was reviewed in NATURE of February 16, 1924, p. 233. Only a few changes of any moment have been made in the new edition. The editor has added in an appendix a good deal of new matter In the present volume the new matter takes up ninety pages, and dealing as it does with such subjects as banking, censuses, the conversion of the national debt, recent budgets, canals, libraries on economics, and the development of economic teaching in recent years in Great Britain, it serves a very useful purpose in bringing up to date some of the more important topics in the body of the book.

This additional information is so good that one is inclined to ask for more The article on bimetallism, for example, might perhaps with advantage have found a place in the appendix, it would have been helpful to have been provided with even a few notes on recent developments. So, too, with the article on commissions of inquiry, which in the body of the book are noted up to the year 1905. The list might well have been continued to include the commissions of inquiry during the last twenty years. The same applies to the article on communism, in which of late there have been some interesting developments. But where there is so much that is good, it is perhaps ungracious to be discontented with omissions. It ought to be noted that the biographies form a useful feature of the volume, and the index, which is the soul of a book of reference, is particularly full and elaborate.

Tychonis Brahe Dani opera omnia. Edidit I. L. E. Dreyer. Tomus VII. Pp. v+422. n.p. Tomus XI. Pp. iv+414 n.p. (Hauniæ: Libraria Gyldendaliana, 1924.)

THE appearance of these two volumes will be welcomed by all who are interested in Dr. Dreyer's monumental edition of the works of Tycho Brahe We note that in the seventh volume Dr. Dreyer's name no longer stands alone on the title-page, but there is associated with him as co-editor Joannes Rørder. The present co-editor's assistance was acknowledged in the prolegomena to the tenth volume, which appeared in 1923, and the assistance given in the preparation of that volume is continued in the eleventh.

Vol 6 of the series contained those astronomical letters written by or to Tycho Brahe which were published by him in his lifetime. Vol. 7 contains in chronological order the rest of his astronomical correspondence down to 1597. The series will be continued in Vol. 8, in which we are also promised notes on Tycho's correspondents and on the persons mentioned in the letters. The non-astronomical letters are reserved for Vol. 14. Most of the letters included in the new volume had been previously published, but the present text is based on MS. originals or MS. copies preserved for the most part at Vienna. Perhaps the most interesting part of the correspondence is that with Thaddæus Hagecius of Prague, physician to the Emperor Rudolf II. Much of the contents of the letters is only distantly related to astronomy. Among the most interesting topics are the presence or absence of parallax in the new star of 1572 and in comets.

Vol. 11 continues the records begun in Vol. 10, and comprises the observations made from 1586 to 1589. The volume also contains a catalogue made in 1589 of zodiacal stars The observations are very varied, and it is to be hoped that a good index will be supplied in a later volume.

Life and Word: an Essay in Psychology By Dr. R. E. Lloyd Pp. xvi+139. (London: Longmans, Green and Co., 1924.) 7*s* 6*d* net.

DR LLOYD'S thesis is that thought, which is verbal, "takes certain *definite* directions which are the directions of human behaviour, but circumstance does *not* lie around us in a *definite* order How, then, can we take our thought from circumstance? It is, therefore, not taken from things, but given mysteriously." The very statement of the thesis would seem to exclude the problem from the purview of science, and, indeed, the book is rather one of philosophical reflection than otherwise, though it contains many acute observations of scientific relevance The author raises the very ancient problem of the universals in a somewhat novel modern form; but his attempt to classify "humanity" by identifying it with "verbal-thought" will scarcely convince contemporary psychologists This "verbal-thought" is looked upon by Dr Lloyd as a function distributed among individuals, in a way similar to that in which a quality or characteristic is distributed among the members of a species, in that, as a whole, it is partly identical and partly different in any given individual.

The view that thought is a *differentia* of human individuals is not a new one. What Dr Lloyd would emphasise is that it varies from one individual to another. But this has long been implicitly realised; and the stress laid upon individual differences by modern psychology is explicit. The difficulty is one inherent in classification, in which concepts must be used which neglect differences and consider only similarities. The little book is puzzling, but suggestive and stimulating to thought.

The Book of Receipts containing a Veterinary Materia Medica, a Pharmaceutical Formulary, a Photographic Formulary; together with numerous Chemical and other Tables likely to be of use to Pharmacists and Manufacturers. By E. W Lucas and H. B. Stevens. 12th edition. Pp. 473. (London: J. and A. Churchill, 1924.) 10*s*. 6*d*. net.

THE scope of this book is sufficiently indicated by its extended title. It is intended mainly for the use of pharmacists, but the photographic formulary and the sets of recipes for microscopical reagents and stains, waxes, varnishes, and special inks, etc., may be useful in scientific laboratories. The authors should consider the desirability of issuing these sections with additions as a separate laboratory receipt book. The collection is at present rather too eclectic to appeal to the average scientific worker.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Essential Hormone of the Parathyroid Gland.

THE essential hormone of the parathyroid gland has been obtained in certain extracts of the fresh glands of the ox (*J. Biol. Chem.*, 1925, 63, 395). Potent extracts have been prepared by first submitting the glands to acid hydrolysis under carefully controlled conditions. The active principle has thus been fractionated along with co-existent substances from the hydrosylate and thus obtained in a relatively high degree of purity.

That a principle contained in these extracts represents the essential normal internal secretion of the parathyroid gland has been shown by the fact that thyroparathyroidectomised dogs on a lean meat diet, treated with these extracts, have been kept free from tetany so long as adequate dosage at proper time intervals has been maintained. The withdrawal of this treatment has resulted in the onset of tetany in these animals. Also, it has been shown that thyroparathyroidectomised dogs which have developed tetany could be restored to normal by the use of potent parathyroid extracts. There is at this time in our laboratory a thyroparathyroidectomised dog which was operated upon some four months ago. This animal is in perfect health. It has been treated continuously with parathyroid extract. Withdrawal of the extract for one day, even after four months of such therapy, has resulted in the precipitation of violent tetany, which has been relieved by the reinstitution of the treatment.

Along with many others, it has been our conviction that parathyroid tetany is primarily due to a lowered calcium content of the blood serum. It was a matter of great interest, therefore, to show that the administration of potent parathyroid extracts results in a mobilisation of calcium salts in the blood-stream. It has been found that potent parathyroid extracts cause a mobilisation of calcium not only in thyroparathyroidectomised dogs, but also in normal dogs. Just as there is a typical blood-sugar curve following the administration of insulin, so also there is a typical blood-serum calcium curve following the injection of active parathyroid extract into dogs. The degree of hypercalcæmia induced in a dog by the injection of a parathyroid extract was also found to be directly related to the size of the dose administered. The potency of parathyroid extracts can therefore be determined with a fair degree of accuracy by the use of several normal animals which are under dietary regulation.

Repeated injection into normal meat-fed dogs of an active extract at intervals of a few hours, has resulted in a condition of profound hypercalcæmia. This condition, if maintained, has ended in a fatal issue. In such cases a typical train of symptoms has been manifested. Many changes in the physical and chemical characteristics of the blood induced by parathyroid hormone overdosage have been observed. Probably the most important of these changes in relation to the fatal issue is a decrease in blood volume and the consequent thickening of the blood itself. Preliminary experiments directed towards the antidoting of the symptoms of parathyroid hormone overdosage seem to point to this as the main factor to avoid or, if present, to counteract. Repeated intravenous injections of hypertonic glucose or saline solutions have proved of definite value. When such treatment has been instituted early in the case of dogs receiving repeated injections of potent extract, the animals lived longer than the controls. No absolute antidote has as yet been found.

It is also of interest to note that typical guanidine tetany has been induced in normal dogs at a time when they were also manifesting a condition of profound hypercalcæmia as a result of repeated simultaneous administrations of guanidine hydrochloride and potent parathyroid extract.

Experiments have shown as well that there is some intimate relationship between the habits of life of an animal and the function of the parathyroid glands. The rabbit, for example, has been found to be peculiarly resistant to repeated injections of the hormone, whereas the dog has been shown to be highly sensitive to it.

J. B. COLLIP

Department of Biochemistry,
University of Alberta,
Edmonton, Canada, April 18.

The Preservation of Fishing-nets, Mosquito-nets, and Tent Fabrics.

It has been shown by H. F. Taylor and A. W. Wells (Bureau of Fisheries, Document No. 947, Washington, 1923) that copper oleate dissolved in petrol or benzol is an efficient preservative for nets immersed in salt water. To avoid the creeping out of the soap to the surface on drying, the ten per cent. oleate solution receives one per cent. of mineral oil or of creosote. In fresh water, less satisfactory results were obtained unless a considerable amount of tar was added as a binder.

I have carried out a few tests, using this method and the results have all been favourable. Silk plankton tow-nets become weakened in about three months' use, varying with the amount of wear. Previous work showed that this is in part due to the action of sunlight, but the major part appears to be due to bacterial action. Silk netting treated with copper oleate was kept in sea-water for six months, the water being changed every other day, and though in time the soap vanished the netting remained sound. Controls were much weakened inside five weeks, and shortly after that could be torn like wet paper. Since silk nets are costly, about 11*l.* for a set of four, and the preservative costs less than a shilling per net, the advantage of using it is obvious.

When tried on stout "stramin" (hemp) netting good results were also obtained, but less striking, for this material is vastly more resistant than silk. In addition to copper oleate a mixed copper soap specially prepared by Mr. W. A. Davis, of Messrs. Lever Bros., was also tried. This, being less soluble than oleate, was used in five per cent. solution. It has proved as efficient, or rather more efficient, than the pure oleate, though used in half the concentration.

After six months in sea-water the lighter stramin netting was found to be rotten, but the piece treated with mixed soaps remained sound, and single threads could only be broken with difficulty. The stouter stramin stank after six months in sea-water; though it could not be torn its appearance and feel had altered and single threads could be broken. The portions treated with oleate and the mixed soaps remained perfectly sound, single threads could not be broken by hand. A sufficient amount of copper soap remained on these pieces to render them much darker in colour than the untreated; of the two the mixed soaps appeared to remain on better than the oleate.

Linen and cotton tentings treated with oleate or

Lever's product lost much of the preservative on the outer side when exposed on the flat roof of the laboratory during the very wet months January and February Fishing-nets treated with these soaps should therefore be protected so far as possible from rain, nor does hanging up to dry appear to be necessary, for sunlight is injurious to all fibres, and the copper soaps protect very effectively against rotting The use of these soaps, mixed with tar for the heavier gear to lessen the rain effect, seems desirable. It may be pointed out that the soaps dissolve only when the nets are in water, but bacterial action goes on so long as the net is damp, so the immersion tests are in this respect unduly severe on the preservative

The treatment of tent fabrics with copper soaps would appear to be useful in climates where the rainfall is not excessive, but where heavy dews prevail, as in parts of Egypt In such climates fungal hyphæ grow among and inside the cotton fibres and holes appear everywhere The inner walls of the eastern pattern tents are also attacked

The decay of mosquito netting in hot damp climates is sometimes a serious matter Doubtless a dip in a dilute solution of copper soap would prove effective in prolonging the life of this netting It could also be used for tennis nets and netting round the courts

W R G. ATKINS

Marine Biological Laboratory,
Plymouth

Diagnosis of Ankylostomiasis.

LIEUT.-COL. CLAYTON LANE, in NATURE of March 28, p 478, criticised the modified floatation method adopted in Egypt for the diagnosis of ankylostomiasis The principal modification lies in using a conical Erlenmeyer flask to hold the fæcal emulsion in concentrated salt solution. This enabled the use of a large amount of fluid (100 c.c), while the surface film does not exceed 1 cm in diameter. Apparently Lieut.-Col. Lane did not give this method a trial, but applied to it the results he previously found in using an inverted metal cone

Any trustworthy method for the diagnosis of ankylostomiasis intended for extensive campaigns should (1) be delicate enough to detect infection with one couple of worms of which one is a normally ovipositing female, (2) be simple and practical, and (3) not be time-consuming It is not essential that the method should ensure the concentration in the surface film of the highest percentage of ova present in 1 c c of the stool so long as enough ova are present to ensure diagnosis The examination is discontinued once a single ovum is detected

If we accept Lane's statement, although it was not proved, that this method detects 7 per cent of the total number of ova, and if we accept Stoll's result that a single fertilised female lays 44 ova per c.c of the stool, we find that the method fulfils the requirements mentioned above, especially as the ova are unmasked and easily detected in films prepared by this method. Lane's results regarding the concentration of the ova, and Stoll's counts as regards the number of ova laid by a single female, have not yet been confirmed by other investigators In view of this uncertainty, the anthelmintic (carbon tetrachloride) is administered to all patients attending the Ankylostomiasis and Bilharziasis Hospitals in Egypt since January 1924, regardless of the results of the microscopical examination Re-examination after the first treatment is restricted to those in whose fæces ova were detected on the first examination

In addition to the floatation method, a fæcal smear is examined from every case in order to detect bilharzia ova, and incidentally ankylostoma ova. It has been found that on an average 30 per cent. of the positive cases for ankylostoma are detected by floatation and missed in the smear. During re-examination after the first treatment, 90 per cent. of the positive cases are missed in the smear and detected by floatation.

Lane mentions as a proof of the inaccuracy of the method that in an Egyptian village in the Delta (Saft el Enab) only 16 6 per cent were found to be infected with ankylostoma, while 40,000 examinations by the smear or centrifugal method showed an infection percentage in different parts of Lower Egypt of 48 to 97 per cent I am unaware of the source from which he got his figures as regards the 40,000 examinations I may, however, mention that the degree of infection in the Delta varies considerably Using the technique mentioned above, it was found that in villages in the neighbourhood of Cairo the infection may be so high as 88 per cent , in the neighbourhood of Benha 60 per cent., in the neighbourhood of Mansura 34 per cent., in the neighbourhood of Dessuk 16 per cent The percentage of infection diminishes as we travel northwards. It is probable that atmospheric temperature influences the incidence of infection in these different localities. This subject is being studied at present. The Delta of Egypt is a large territory, and it is inaccuate to treat it as a whole as regards the incidence of ankylostomiasis

As regards the importance of accurate study of ankylostomiasis from its various aspects in Egypt, I may assure Lieut.-Col Lane that the Egyptian Government is fully alive to its responsibility It had already started, towards the end of 1922, a research section devoted to the study of ankylostomiasis and bilharziasis M. KHALIL.

Department of Biology and Parasitology,
Royal School of Medicine, Cairo, Egypt, April 4

THE community percentages of hookworm infection for Egypt of 48 to 97 obtained by the use of Howard's, the least efficient concentrative diagnostic technique, emerge from analysis of Khalil's tables. A percentage of 16 6 for his floatation method indicates then either an unluckily chosen experimental site or an undependable technique It was held that the evidence suggested that the latter factor was involved. This conclusion would indeed seem to be Khalil's also, since he writes: "It is probable that some of my negative results were due to the very few ova which escaped the attention of the examiner" (p. 82). Put otherwise, his first requisite for a trustworthy diagnosis—namely, that the technique must be "delicate enough to detect infection with one couple of worms of which one is a normally ovipositing female"—is an ideal which he seemingly holds unattained by his own technique.

But the fundamental point in the criticism lay in that, being without knowledge of the number of ova with which, in any instance, his technique started, he necessarily remained ignorant of the percentage which it finally delivered. The later statement, that it is better than the worst concentrative technique, does not even now rectify the matter. Its real value can only be indicated by such methods of control as are being applied in various parts of the world, already with a considerable measure of success. Without a controlled, and therefore scientific, basis for the work, the Egyptian campaign, so heavily subsidised by the Rockefeller Foundation—at the expense of which so much of the recent widespread experimental work on control has been carried out—must clearly remain of minor value.

CLAYTON LANE.

Homologies of the Genital Ducts of Insects.

IT is unfortunate that even the most recent text-books of entomology are not up-to-date in their accounts of the above organs. It is only with regard to the ectodermal parts of the ducts that opinions have differed; otherwise it is admitted by all that ovaries and oviducts correspond to the testes and vasa deferentia respectively. In every book, old or new, one finds the median ejaculatory duct homologised with the median vagina. This homology is open to serious objection: the ejaculatory duct opens in all insects, excepting the Ephemeroptera, behind the ninth sternite, and is unpaired from the very beginning, while the vagina or the uterus opens in

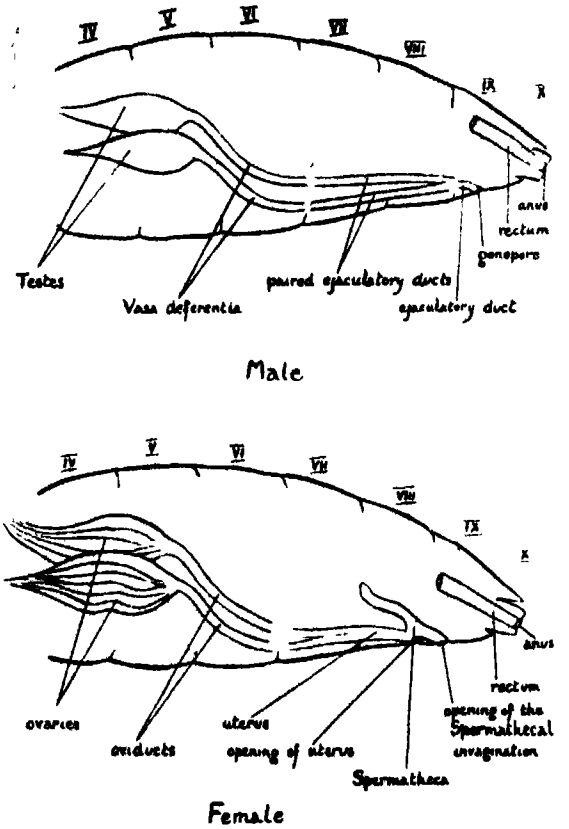


FIG 1.—Scheme of the development of the reproductive organs of an insect Accessory gland not shown.

most insects between the eighth and ninth sterna, and is paired in origin in many orders.

In the young male there is an hypodermal invagination of the body wall behind the ninth sternum, the rudiment of the median ejaculatory duct. This invagination at its anterior end, about the posterior region of the eighth sternum, meets and opens into a pair of ectodermal ducts, termed the paired ejaculatory ducts, which as development proceeds get into communication with the vasa deferentia. In the case of the young female there is also an invagination of the integument behind the ninth sternite which develops into the spermatheca. The spermathecal rudiment about the posterior margin of the eighth sternum opens into an ectodermal duct, the uterus or vagina, which, as mentioned above, arises in many insects by coalescence of a pair of ducts. The uterus at a later stage in development becomes continuous with the oviducts. Evidently, therefore, the median ejaculatory duct of the male corresponds to the spermatheca of the female, and not to the vagina or uterus. The homologue of the latter are the paired ejaculatory ducts. Diagrams of the scheme of the organs appended herewith illustrate the above remarks (Fig. 1).

The only difference (but which has caused a considerable amount of confusion) between the organs of the two sexes is that while the median ejaculatory duct meets and opens into the paired ejaculatory ducts at its extreme anterior end, the spermatheca does so about the middle of its length, with the consequence that its anterior half remains free, increases in size, and appears as a diverticulum of the uterus. Moreover, unlike the uterus, the paired ejaculatory ducts have no opening of their own in the present-day insects. But in Coleoptera, and probably in Diptera also, the uterus, like the latter, has, morphologically speaking, no opening of its own and communicates with the exterior through the opening of the spermatheca, and therefore the female gonopore, unlike that in other orders, lies behind the ninth sternum. The spermatheca, except in the Coleoptera, Diptera, etc., loses its proper opening and communicates with the exterior by the opening of the uterus. In the Lepidoptera, however, both the spermatheca and the uterus retain their proper apertures even in the adult stage, with the consequence that there are two "genital openings," one behind the other, in this order. In the Ephemeroptera also there are two openings, but they lie on the same segment, the seventh.

HEM SINGH PRUTHI.

Zoological Laboratory,
Cambridge, April 22.

Fossils and Leonardo da Vinci.

IN his valuable and sympathetic appreciation of Huxley on the occasion of the centenary celebrations on May 4, Prof. Poulton incidentally referred to the puzzled discussions of naturalists of former days concerning the fossil sharks' teeth ("glossopetræ") that were found in Italy.

It is interesting to compare their mental attitude and their almost complete and unimaginative ignorance with the acute and unerring perception of the supreme genius of all time—Leonardo da Vinci.

In "The Literary Works of Leonardo da Vinci" (Richter, 1883, p. 208 *et seq.*) he discusses very fully the presence of fossils in the Italian mountains. His immediate object is to show that the Noachian flood could not be responsible for this; and his many-sided arguments indicates the clearest understanding of the formation of strata by deposition from rivers, and of earth movements, in their connexion with the preservation and present position of fossils. His particular views are supported by the following statement:

"And if you were to say that these shells were created, and were being continually created in such places by the nature of the spot, and of the heavens which might have some influence there, such an opinion cannot exist in a brain of much reason, because here are the years of their growth, numbered on their shells, and there are large and small ones to be seen which could not have grown without food, and could not have fed without motion—and here they could not move." With such a mental attitude (existing at a period that was steeped in astrology) what a mighty ally Leonardo would have been to Darwin and Huxley!

One of his other arguments against the assistance of the Deluge, in the part of Italy that he investigated, is characteristic of his incessant interest and scientific watchfulness. "We have it in the Bible that this

deluge lasted 40 days and 40 nights of incessant and universal rain . . . and if you were to say that . . . the shells quitted their first home" [near the seashore] "and followed the increase of the waters up to their highest levels . I answer, that the cockle is an animal of not more rapid movement than the snail is out of water or even somewhat slower; because it does not swim, on the contrary it makes a furrow in the sand by means of its sides, and in the furrow it will travel each day from 3 to 4 braccia, therefore this creature, with so slow a motion, could not have travelled from the Adriatic Sea, as far as Monteferrato in Lombardy, which is 250 miles distance, in 40 days," which he has said who took account of the time ".

The last few words are probably not free from an intended gentle sarcasm (we meet it again elsewhere), but how unanswerable is this argument, as are many others, of this brilliant observer and thinker!

Leonardo refers also to "the bones and teeth of fish, which some call arrows and others serpents' tongues "—surely the very "glossopetræ" already mentioned.

What puzzled naturalists of later times was abundantly clear to him of the fifteenth century.

PERCY EDWIN SPIELMANN.

The Athenæum, May 5.

The Identity of "Alumen" in Pliny's Natural History.

"ALUMEN" is mentioned frequently in the Historia Naturalis of the elder Pliny, and there has been some controversy about its identity. It is probable that the term was used loosely to describe a number of astringent salts, and it is clear from the tests prescribed in Pliny, H N. 35, 184-5 (the blackening of pomegranate juice and nut-galls), that the word was sometimes used to describe a compound of iron, perhaps the sulphate, derived from iron pyrites by oxidation. Ajasson, however, boldly identifies the "alumen" mentioned in H N. 33, 88, as sulphate of aluminium, but gives no reasons for so doing.

The passage in question concerns the preparation, for use as a pigment, of "chrysocolla". Though the identity of this latter substance has been a matter of dispute in the past, there is now general agreement that it was malachite, or basic carbonate of copper. The passage runs as follows:

H N. 33, 87 "(Chrysocolla) illa quoque herba quam lutum appellant tinguitur.

88 "Pulvis (sc. chrysocollae) semper in catino digeritur et ex aceto maceratur ut omnis duritia solvatur, ac rursus tunditur, dein lavatur conchis, siccatur. Tunc tinguitur alumine schisto et herba supra dicta, pinguiturque antequam pingat.

89 "Summa commendationis, ut colorem in herba segetis laete virentis quam simillime reddat."

There is little doubt that "lutum" is the "reseda luteola" or weld, an extract of which dyes yellow with aluminium mordants and greenish olive with iron mordants.

The writer prepared an extract of weld by boiling the chopped-up plant with water. Finely-powdered malachite (bluish-green in colour) was treated with vinegar, washed, and boiled with weld extract to which had been added (*a*) aluminium sulphate, (*b*) ferrous sulphate, or (*c*) iron alum. The colour finally obtained depended on the proportions of dye and mordant and on the time of boiling, but in a general way (*a*) gave an emerald green powder, while (*b*) and (*c*) gave dark greens—approximately the colour of the holly leaf.

It seems clear that the former is the colour referred to as "colorem in herba segetis laete virentis" rather than the latter. It is almost certain, therefore, that "alumen" includes salts of aluminium as well as salts of iron.

In conclusion, it should be added that Dioscorides (5, 104), in a sentence the exact meaning of which is uncertain, seems to describe "chrysocolla" as being of "a full leek green," but it is probable that he is speaking of the original material and not of the dyed product as he does not mention the dyeing process at all.

KENNETH C. BAILEY.

Trinity College, Dublin, March 23.

Effect of an Alternating Magnetic Field on the Polarisation of the Resonance Radiation of Mercury Vapour.

RECENTLY, A. Ellett (NATURE, December 27, 1924, p. 931) and W. Hanle (*Zs. f. Phys.*, 30, 93, 1924) observed the depolarising effect of a weak magnetic field on resonance radiation. When the intensity of the field was sufficiently small they found, not only partial depolarisation, but also a rotation of the plane of polarisation. This is accounted for, on the classical point of view, by the superposed effect of the Larmor rotation and of the damped vibrations of the oscillator.

The same classical views suggest that the depolarising action of a high frequency alternating magnetic field of constant amplitude will vanish with increasing frequency. The effect should be well observable with fields of 2 or 3 gauss, and frequencies between 10^6 and 10^7.

We have performed the experiment, and have detected the presence of the expected phenomenon. A strong increase of the polarisation was actually observed in passing from a frequency of 1.5×10^6 to one of 5×10^6, though the amplitude of the field remained constant.

We are carrying out further experiments in order to determine the quantitative features of the effect.

E. FERMI.
F. RASETTI.

Istituto Fisico dell' Università,
Firenze, Italy, April 3.

Visible Wind.

IN reference to the report published in NATURE of May 2, of the Royal Meteorological Society's "Celebrations," including the interesting address by Prof. E. van Everdingen on "Clouds and Forecasting Weather," may I be allowed to remind international meteorologists that in 1906, by official sanction in Great Britain, the status of "wind waves" was raised from that of a purely theoretical deduction to that of a normally observable natural phenomenon. "Wind waves" operating in the free and cloudless air are recognisable as such from among other sources of deformation of the definition of telescopic images. They are most adequately observable by means of a telescopic image of the sun projected for the purpose into a darkened room. Their approximately horizontal progressive wave-motions describe prevailing conditions of atmospheric stratification, wind directions, and turbulence above the place of observation always ahead of and generally many hours ahead of any visible formation of associated clouds. Thus the main objects of cloud-observation are obtainable by means of *yet earlier* observations of winds, up to all heights of known cloud formation, in any brief moment of sunshine, with the utmost ease and expedition. But Ruskin is aptly quoted by the writer of the report to the effect that "the meteorologist is impotent if alone."

CATHARINE O. STEVENS.

The Plain, Boar's Hill, Oxford.

Single Spark Photography and its Application to some Problems in Ballistics.

By P. P. QUAYLE, Assistant Physicist, U.S. Bureau of Standards.

SPARK photography, in which the illumination is provided by an electric spark of such short duration that a moving object appears stationary, has many applications in the investigation of high-speed phenomena. The record obtained is not an image, no lens being used, but is simply the silhouette of objects between the light source and the photographic plate Two distinct problems are presented in the photography of moving objects. One of these is the timing of the spark so that the desired epoch of the phenomenon under investigation may be photographed, and the other has to do with the duration of the spark. All the photographs described in this article were taken on plates not larger than 8 by 10 inches. A projectile moving at a speed of 2700 feet per second would be in front of such a plate, and therefore in a position to be photographed, for only 0·0003 second. If the projectile is to be photographed within an inch of a predetermined position, the time of occurrence of the spark must be correlated with the position of the projectile to within 0·00006 second.

The spark duration determines the amount of blurring, for if the projectile moves while the plate is being illuminated a streak will be recorded, the length of which depends on the duration of this spark. If the blurring is not to extend over more than one-sixteenth of an inch for a projectile moving at a speed of 2700 feet per second, the time of exposure must not exceed two millionths of a second.

It is interesting to contrast the requirements which are imposed upon the apparatus just referred to with those imposed upon ordinary moving picture cameras in taking the so-called action photographs of the daily press. While many camera shutters are rated to operate in 0·0006 second, they seldom function in less than 0·002 second, and 0·005 second is a more common time of exposure. In photographing a racing car moving at 120 miles per hour, using a shutter which operates in 0·002 second, the car will move approximately 4·2 inches during the exposure interval. Exposure times which are satisfactory for photographs of polo matches, track and field work, etc., are ten times too long for photographing a racing car and ten thousand times too long for photographing a projectile at right angles to its trajectory. If the photograph is not taken at right angles to the trajectory the requirements are less severe. This point is well illustrated in the case of a 4·7 in. field-piece, say, firing so that the projectiles are silhouetted against the sky. If the day is clear, an observer standing behind the piece can see the projectile with the naked eye at a distance of three hundred yards from the muzzle and follow it without difficulty for a thousand yards or more along its trajectory.

In order to secure a properly timed spark of suitable character there must be available a means of generating electrical energy at very high voltage; a means of storing such energy; apparatus for the regulation of the voltage; and finally, a means of releasing the stored energy at the proper time. The manner in which these parts are associated is shown diagrammatically in Fig. 1. In our equipment the generator consists of a motor-driven influence machine having two revolving plates 17 in. in diameter. A 0·024 microfarad Leyden jar condenser constitutes the means of storing the energy for the photographing spark. The apparatus for regulating the voltage of the condenser includes a dynamometer or potential regulator and a switch which disconnects the condenser from the influence machine when the voltage across its terminals reaches a definite value determined by the regulator adjustment.

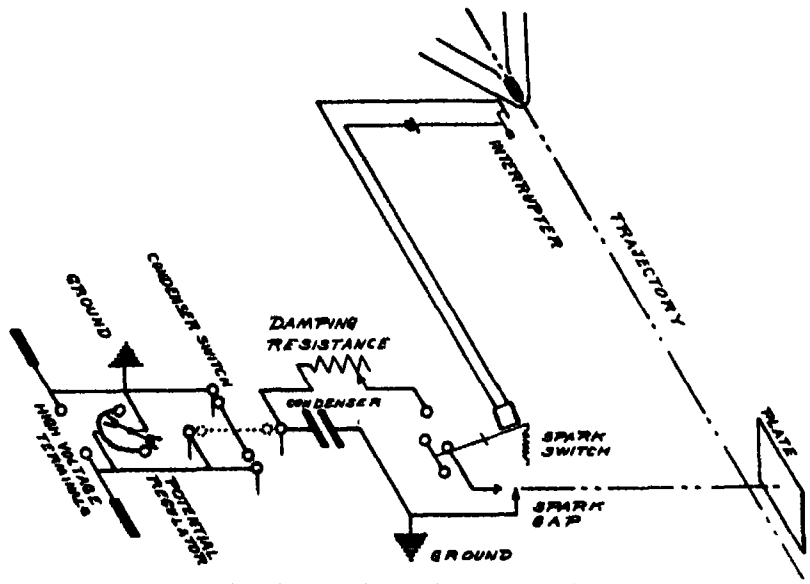


FIG. 1.—Schematic wiring diagram of spark photography apparatus

The arrangement for releasing the photographing spark also consists of two parts. The first part is an electromagnetic switch which closes a trigger spark gap. The second is an auxiliary device which serves to time the operation of the previously mentioned switch with respect to the phenomenon to be photographed. This auxiliary device takes different forms in varying circumstances. For example, when projectiles are being photographed well away from the gun, an interrupter is used which is placed near the trajectory and opens an electric circuit when the head wave of the bullet passes over it.

CYCLE OF OPERATIONS.

When a photograph of a projectile is to be taken, the following steps are involved. The operator sets or cocks the spark switch and the condenser switch, having previously placed the interrupter a short distance away from the trajectory and at a sufficient

distance from the photographic plate to allow for the 0·0048 second time lag in the apparatus. This position is determined by trial. The lag of the spark switch may be determined experimentally. If this lag is known, a simple computation based on the approximate speed of the projectile and the lag value will definitely determine the position for the head wave interrupter. After the influence machine has been started, the voltage across the condenser builds up until the point is reached at which the regulator functions The closing of the regulator contacts energises the tripping magnet of the condenser switch, which in turn promptly disengages the arm and short-circuits the influence machine, thus preventing the accumulation of further charge on the condenser. This arm, through the buffer, automatically turns on the signal light and the operator immediately fires.

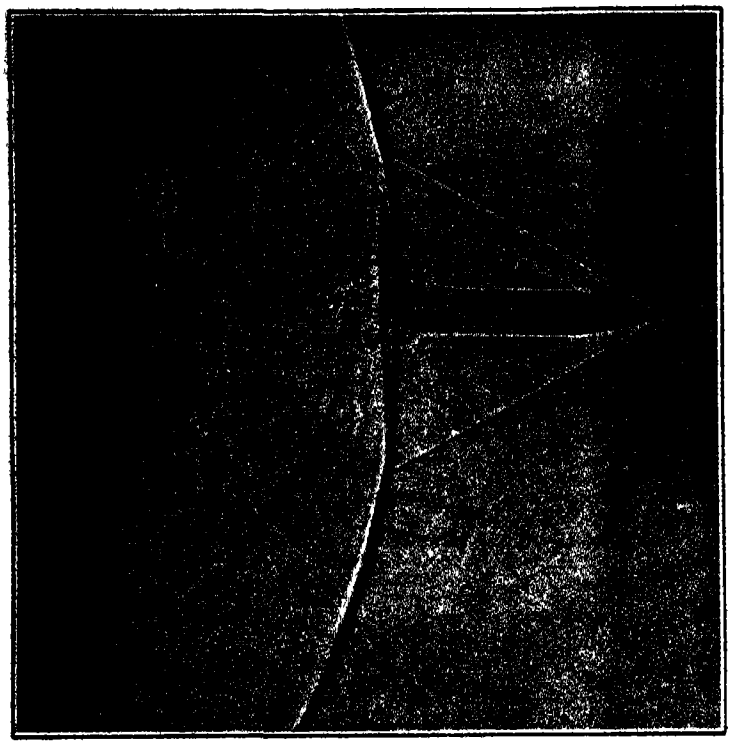


FIG. 2.—Bullet from a 0·30 Springfield rifle about 11 in. from the muzzle. The bullet is well in advance of the propelling gases. M is the boundary wave.

The bullet moves out from the muzzle and passes the interrupter in its progress toward the plate. As the sound waves which accompany the bullet pass the interrupter the circuit breaker is thrown open, the magnet of the relay is de-energised and the armature catch is released. The switch arm then closes the trigger gap and the condenser discharges through it and the photographing spark gap with which it is in series. If the interrupter has been properly located, the spark occurs at the instant the bullet arrives in the desired position in front of the plate [1]

Comparison with other Methods.

The first spark photographs of projectiles in flight seem to have been taken about 1881 by Prof. E. Mach, of the University of Prague, who carried out a remarkable series of experiments along this line. Prof. Mach utilised the so-called Schlierenapparat devised by Toepler for making visible those portions of a transparent medium which differ but slightly in refractive index from that of their surroundings. Hence his images were small and required the utmost in photographic manipulation to develop them Prof Mach triggered his photographing spark by firing the bullet through a secondary trigger gap, and while this method is positive, the wires of the trigger gap appear in the photograph.

Dr. L. Mach, in 1893, attacked the problem with several modifications of the earlier apparatus and a most ingenious trigger device. His efforts were attended by marked success. L. Mach's

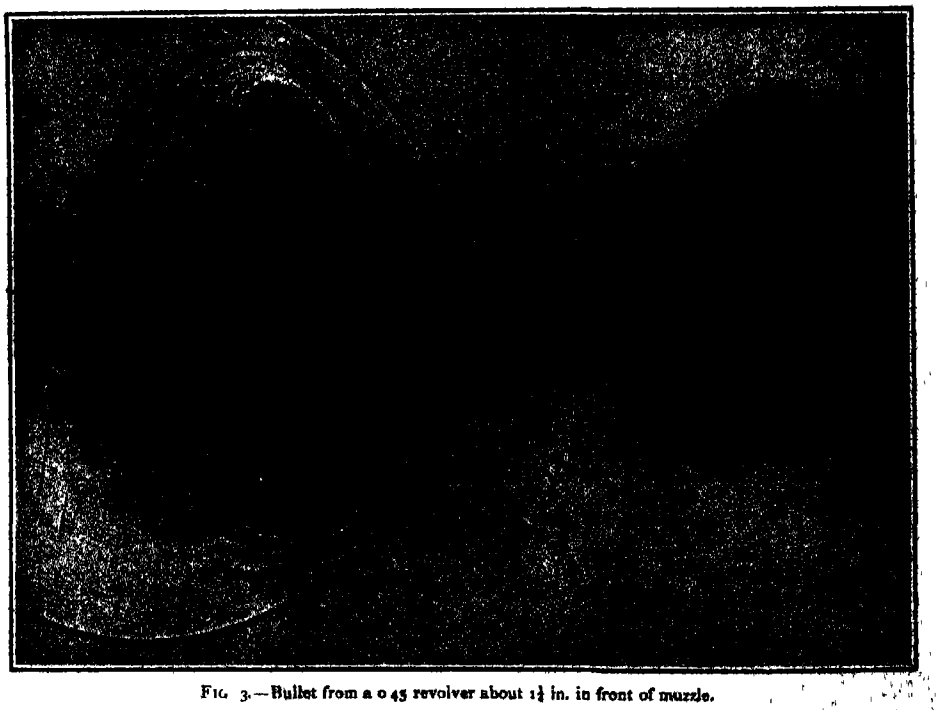


FIG. 3.—Bullet from a 0·45 revolver about 1½ in. in front of muzzle.

[1] A more detailed description of the apparatus with illustrations is given in a Bureau of Standards paper now in press entitled, "Single Spark Photography and its Application to Ballistics."

apparatus was also based upon Toepler's method, but he replaced the lens of the earlier apparatus by a large concave mirror, which gave a larger field and more intense illumination. L. Mach triggered his spark by means of a compressional wave started by the passage of the projectile through a special device designed for the purpose.

From data found in Mach's papers, and from general information concerning the rifles in use at the time his work was done, it appears probable that the speed of the projectiles photographed by him did not exceed 1900 feet per second

C. V. Boys [1] in 1893 introduced the direct shadow method of bullet photography employed in this paper. The sound waves and other air disturbances produced by the flight of the bullet are recorded in the photographic plate owing to the fact that their refractive indices differ from that of the surrounding air. Boys used the triggering device employed by E. Mach, which shows in each picture, but his photographs are among the best ever obtained.

Excellent photographs similar to those of Boys were published by W. A. Hyde in Ordnance Pamphlet, No. 422, U.S. Navy Department, in 1913.

All the methods of photographing projectiles in flight discussed up to this time have one point in common, namely, that in triggering the photographing spark the motion of the projectile is interfered with in some way. In the earlier triggers, the projectile closed a gap mechanically. Then L. Mach fired his bullets through paper cylinder heads causing a compressional wave in a small tube. The use of the interrupter described here, and in the earlier publication of the present writer [7] referred to, yields photographs in which no part of the photographing mechanism appears, and in which the bullet is not touched in any way.

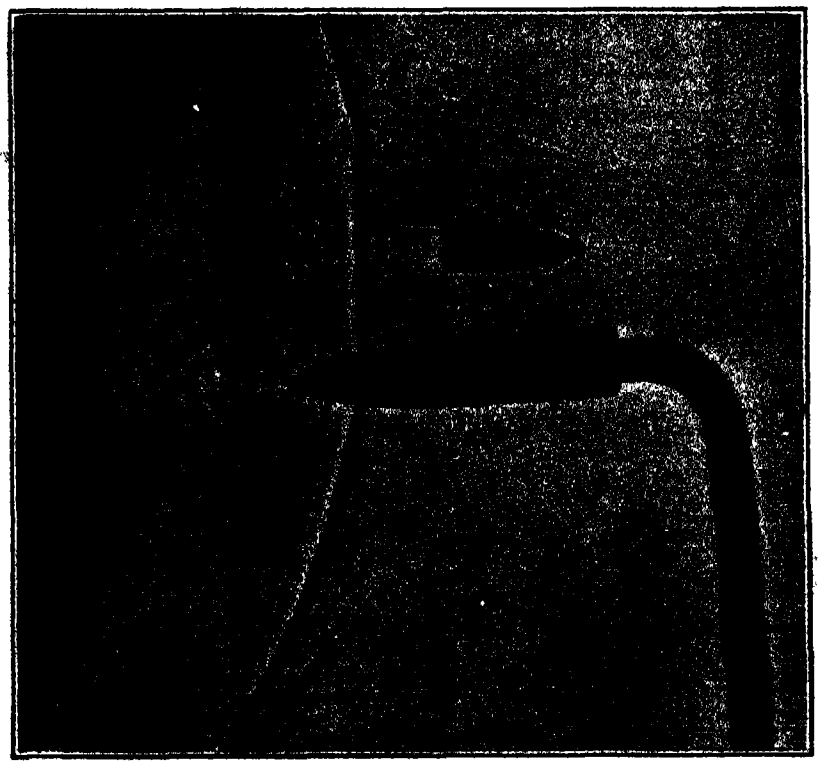


FIG. 4.—Stationary projectile within the boundary wave M sets up an ordinary sound wave S.

ACCELERATION OF PROJECTILES AFTER LEAVING MUZZLE.

Opinion appears to be prevalent that a projectile continues to be accelerated for a considerable distance after leaving the muzzle of the gun. Thus John W. Hicks in his book, "The Theory of the Rifle and Rifle Shooting" (1919), quotes Dunn of the Ordnance Department, U.S.A. (1897), as saying: "Small arm bullets should be considered as having their maximum velocity at points from 20 to 30 feet in advance of the muzzle. They should gain in velocity over this distance for the bullet is enveloped in gases moving in the same direction and with higher speed than that of the bullet. . . ." No refutation of this view has been found in the literature. Photographs taken during the course of this investigation indicate, on the other hand, that the service projectile of a calibre 0·30 Springfield rifle ceases to be accelerated within a foot of the muzzle. Such a photograph is shown in Fig. 2. The muzzle of the rifle does not appear in the photograph, but, from measurements made at the time the photograph was taken, it is known that the centre of the plate was eleven inches in advance of the muzzle. It will be seen that the bullet is already well in advance of the outermost boundary of the propelling gases, and since the bullet has set up its normal head wave, it is subject only to the retarding forces considered in exterior ballistics.

Other photographs, taken of a bullet four or five inches in advance of the muzzle, show that in this position the powder gases are being deflected from the base of the bullet and consequently the bullet is being accelerated. At a distance of from six to eight inches in front of the muzzle the speed of the powder gases falls below that of the bullet, and at a distance of eleven to twelve inches the bullet has outdistanced all the blast effects, with the possible irrelevant exception of a few stray powder particles, and cannot be overtaken by any accelerating forces of the discharge.

Fig. 3 shows one of a series of fifteen photographs taken of the discharge of a 0·45 calibre double action revolver, model of 1909. In this photograph the bullet is about 1¼ inches in front of the muzzle. The bullet is still being accelerated, since the propelling gases are being deflected from its base. Other photographs show that for this particular arm and ammunition the bullet ceases to be accelerated within a distance of 6 inches from the muzzle. Phenomena such as those depicted in these photographs are not to be considered

as representing a random distribution of the powder gases of the propelling charge which have been recorded by a fortunate exposure of the plate. They are, on the contrary, perfectly definite stages of a cycle which repeats itself over and over again for the same arm and powder, and any particular stage of the phenomenon can be duplicated within narrow limits.

GAS MOTION AT THE MUZZLE.

The photograph shown in Fig. 2 possesses features of interest in addition to its bearing on the acceleration of the projectile. Let us consider the state of the gases inside the boundary wave *M*. It will be seen that the head wave of the bullet does not extend rearward beyond the wave *M*. The absence of this wave inside

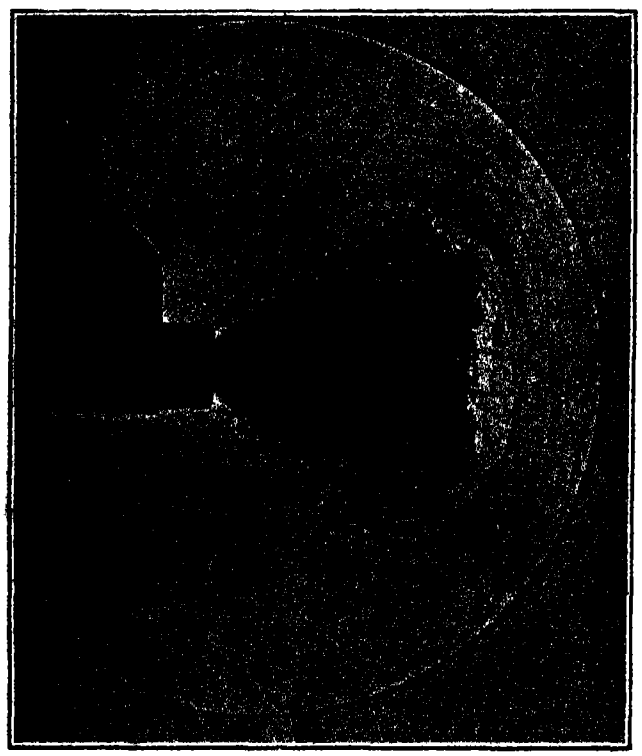


FIG. 5.—Gas leakage from a 0.30 Springfield rifle. Photograph taken before the bullet emerged.

of *M* is to be ascribed to the fact that in this region the speed of the projectile relative to the gas is less than the speed of sound in the gas, for otherwise a head wave would be formed. It therefore follows that the gases behind this wave are moving forward at considerable speed, or that the speed of sound in this medium is quite high, or that a combination of these conditions exists

If the absence of the head wave, above mentioned, is due to the forward motion of the gases inside the wave *M*, a stationary projectile set up in this region should show a head wave pointing in the direction from which the gases are coming, providing that their speed is above that of sound in the medium. However, the actual experiment, the result of which is shown in Fig. 4, showed no such wave at the nose of the stationary projectile and therefore *G*, the speed of the gases, is less than the S_0, the speed of sound in them. However, when this fixed projectile pierced the wave *M* it started an ordinary sound wave *S* which at the moment it was photographed had attained a diameter as measured on the plate of 1·44 inches. We may assume that the centre of this wave was originally at the point of the bullet, but a pair of compasses will show that its centre is now displaced about 0·38 inch, and that it is practically undistorted. This absence of distortion of the spherical wave while its centre has been moved 0·38 inch indicates reasonably uniform motion of the medium in which it is propagated. Furthermore, if the gases inside the wave *M* were moving forward with the speed of sound in the medium, then the portion of the spherical sound wave nearest the muzzle could not move from the point of the projectile at which it started. If, on the other hand, the gases were stationary, the wave would expand, keeping the point of the projectile as a centre The actual case is somewhere between these two. While the sound wave has moved out until its radius is approximately 0·72 inch, it has been moved forward as a whole 0·38 inch; hence the forward speed of the gases must be 0·38/0·72 or 0·53 that of the speed of sound in the gases.

From the relative positions of the moving projectile and wave *M*, it follows that the average speed of the projectile is slightly greater than that of the wave *M*, assuming that the base of the projectile and the wave left the muzzle at very nearly the same time. If we also assume that the speed of the wave *M* has not increased, then since we know that the speed of the bullet has increased somewhat above its mean speed, it follows that the present speed *P* of the bullet is greater than the present speed *W* of the wave. Hence the speed of the gases is something less than half that of the projectile and the speed of sound in these gases is something comparable with that of the projectile.

If in Fig. 4 we let

P = speed of projectile,
W = " the wave *M*,
G = " gases immediately behind *M*,
S_A = " sound in free air.
S_0 = " sound in gases immediately behind *M*.

The arguments just presented may be summarised as follows:

$$G = \tfrac{1}{2}S_0, \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$S_0 = W, \quad . \quad . \quad . \quad . \quad . \quad (2)$$
$$P > W. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The condition that no head wave shall exist behind the wave *M* is

$$P - G < S_0, \quad . \quad . \quad . \quad . \quad (4)$$

or in view of (1) and (2)

$$P < \tfrac{3}{2}W. \quad . \quad . \quad . \quad . \quad (5)$$

But it was found from the relative positions of the wave front *M* and the projectile that *P* is only slightly greater than *W*. It therefore follows that condition (5) is satisfied and the absence of the head wave in the region behind *M* is accounted for.

GAS LEAKAGE.

Since the first introduction of firearms, a leakage of the gases of the propelling charge past the projectile has represented a great waste of the available energy. Little could be done to reduce this loss in the case of



FIG. 6.—0·30 calibre projectile after passing through a bubble containing a mixture of hydrogen and air. The head and base sound waves are considerably modified.

the smooth-bore and rifled muzzle loaders in use up to half a century ago. The projectile could not be made to fit the bore too snugly since the ball and its accompanying wad could not then be forced down upon the powder charge; and when the size of the ball was so reduced as to make loading at the muzzle feasible, the fit was at best rather poor

With the introduction of the breech loader and fixed ammunition, the first real step towards reducing gas leakage was achieved. In these arms the cartridge fits nicely into a breech chamber, the forward end of which leads by a short cone to the lands and grooves of the rifling. In the case of a lead bullet, the metal is suddenly forced into a rifled tube having a diameter (measured between lands) slightly smaller than that of the projectile, so that the soft metal is forced into the grooves making a seal to which the older arms could never approximate. The improvement is, however, a relative one, since gas leakage is still present in the best arms of to-day, though, of course, on a greatly reduced scale.

Fig. 5 shows the gas leakage which accompanies the firing of a 0·30 calibre Springfield rifle. The photograph was taken before the bullet emerged from the muzzle, and the dark mass of gas in front of the muzzle consists largely of powder gases which have leaked past the projectile. The heavy black spherical wave which forms the envelope of all other disturbances produced by the discharge originated with the unseating of the bullet from the cartridge case. The resultant pulse or compression wave passed down the rifle tube and travelled outward from the muzzle.

MODIFICATION OF SOUND WAVES BY THE MEDIUM.

The explanation, by C. V. Boys, of the formation of the sound waves which attend the motion of a projectile makes it clear that the regular head and base waves cannot be formed unless the speed of the projectile is equal to or greater than the speed of sound in the medium. Since the speed of sound in hydrogen gas is considerably greater than that of the service projectiles, it follows that a projectile entering a soap bubble filled with hydrogen gas should lose its head and base waves, which should reappear when the projectile emerges into the air. These conclusions have been fully confirmed from photographs which have been taken at the Bureau of Standards with the apparatus described in this paper.

Fig. 6 shows a 0·30 calibre projectile after passing through a soap bubble filled with a mixture of hydrogen and air. In this photograph, the sound waves attending the projectile have been considerably modified in form due to travelling for a time through a medium in which the speed of sound was considerably greater than that of air.

TRACER BULLETS.

Fig. 7 is a photograph of a tracer bullet taken approximately 35 ft. from the muzzle. It appears to have been generally believed that the strong light which tracer bullets emit would make it impossible to photograph them successfully, and visual observation tended to confirm this belief. This photograph was obtained by using a rectangular tube of black paper with its axis at right angles to the trajectory and coincident with the

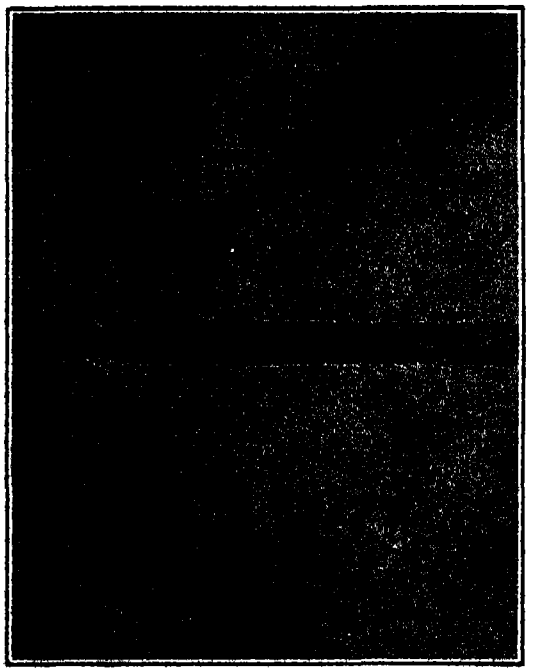


FIG. 7.—Tracer bullet approximately 35 ft. from the muzzle. The base wave is almost completely absent

line joining the spark gap and the centre of the photographic plate. By this device the plate was shielded against the tracer light before and after the bullet had traversed the tube. The plate is fogged, of course, but it nevertheless shows some interesting details.

The most striking thing is the almost complete absence of a base wave. The usual base wave is undoubtedly associated with the rapid pressure drop at

the base of the projectile. Apparently the gases generated by the tracing compound prevent the formation of a region of diminished pressure, and hence the formation of a base wave. About two inches back from the base of the tracer bullet, particles of the tracing compound can be seen as they leave the wake.

In conclusion, the author wishes to express his indebtedness to Dr. E. A. Eckhardt for suggestions and assistance in the experiments and in the preparation of the manuscript, and to Drs. L. J. Briggs and E. Buckingham for their kindly interest in the experiments and their helpful suggestions and criticisms.

The courtesy of the Frankford Arsenal in furnishing some of the arms and ammunition is gladly acknowledged. Most of the photographs here presented were taken in the process of developing the design of bullet photography apparatus for the use of that organisation.

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Hindu Astronomy.

THE study of the origin and progress of Indian astronomy has attracted a good deal of attention among Orientalists and historians of astronomy during the last 140 years, and has given rise to a considerable amount of controversy, which now seems to have ceased, at least among competent scholars. The history of the literature of the subject down to 1893 was written by the late James Burgess (Journal of the Royal Asiatic Society, October 1893) and need not detain us here. While during the last seventy years critical editions and commentaries of the Siddhântas or textbooks have finally silenced the opponents of the connexion between the later Hindu astronomy and that of the Alexandrian Greeks, attention has also been directed to the earlier Vedic and post-Vedic periods. But a general account of the subject in the English language was wanting, and this has now been supplied in a valuable memoir by Mr. G. R Kaye,[1] who had already published several minor papers on Indian science, and an exhaustive monograph on those strange aftermaths of Muslim astronomy, the great masonry instruments of Jai Singh.

The earliest sacred works of the Hindus, known as the Vedas, contain astronomical references of interest, and there is from the post-Vedic period a formal work on astronomy, the Jyotisha Vedânga, which claims by its title a fairly close connexion with the Vedas. The knowledge of astronomy in the Vedic period was very scanty; the year had 360 days, with an occasional intercalary month, not clearly defined; the ecliptic was divided into 27 or 28 nakshatras or lunar mansions. The Vedic seers must have had some knowledge of the planets, yet there is no explicit reference to them in any of the Vedic writings, though it is possible that in the Rigveda Jupiter is meant by Brihaspati, by which name the planet was known later on. In the post-Vedic period (about 400 B.C.–A.D. 200) we find a five-year cycle of 5×366 savana or civil days. The nakshatras are nowhere in these early works definitely connected with particular stars or constellations. Attempts have been made to assert that the early Hindu writers had knowledge of the precession of the equinoxes, but as their year was 18 hours too long, and their methods of observing were very crude, they could not possibly have anticipated the discovery of Hipparchus, which even the Babylonians, notwithstanding their accurate knowledge of astronomical periods, were unable to do.

About the fourth century A D., however, a very great change took place in the Hindu astronomical teaching. As we have already remarked, no European scholar now doubts that the new teaching was solely due to Greek influence, and only some Indians, influenced by sentiment, continue to deny it. The Greek kingdom of Bactria had come to an end in the first century B.C., but a revival of intercourse between India and the West certainly began in the second half of the fourth century and was continued by Nestorian missionaries, who from Persia wandered all over the East. Our principal sources of information about the new science are the Aryabhatiya of Aryabhata (composed in A.D. 499), Varaha Mihira's Panchasiddhantika (about A.D. 550), a similar work by Brahmagupta (about A.D. 630), and the Sûrya Siddhânta, which in the form now extant is later than A.D. 1000, but is founded on a much older original. Albiruni's celebrated book on India (A.D. 1031) is also a valuable source.

The first glance at one of the siddhantas shows the Greek origin of the contents. Greek words connected with geometry, astronomy, and astrology have been transferred into Sanskrit books with very little modification; thus horizon became harija, diametron jamitra, trigonon trigona, lepte liptâ (a minute of arc), kentron kendra (also as meaning the arc of the excentric from the apogee to the centre of the epicycle), and many other terms. The nakshatra divisions of the zodiac were almost altogether superseded by the signs of the zodiac (previously unknown in India), and here again their origin is betrayed by their names: Kriya, Tâvuri, Jituma, Karkin, Leya, etc., are clearly nothing but Krios, Tauros, Didymos, Karkinos, Leon, etc., though later works also use translations of the Greek names. But even more remarkable is the fact that the motions of the planets, which formerly had been completely ignored, were now dealt with in considerable detail, and altogether by Greek methods, adopting the theories of excentric circles and epicycles developed in Alexandria. Everything in the siddhantas is borrowed from that seat of learning. Parallax and methods of calculating it were described, and it was shown how to calculate eclipses, a subject quite new to Indian works. The length of the year was properly determined and various problems of spherical astronomy were solved.

There are some details of the Ptolemaic theory of planetary motion, which are not found in Hindu astronomy, namely, the equant or centre of equal motion different from the centre of equal distances, and certain complicated details in the theories of the moon and Mercury. It looks as if the date of the

[1] Memoirs of the Archæological Survey of India, No. 18. "Hindu Astronomy," by G. R. Kaye (Calcutta, 1924, 134 pp.).

original work, which was introduced into India about the fourth century, was somewhat anterior to that of Ptolemy (A.D. 140), and this seems also to be indicated by the treatment of precession as a mere libration of the equinoxes. On the other hand, the apparent deviation of the epicycle from the circular form (which is not found in Ptolemy's work) may possibly be derived from an earlier attempt to represent what Ptolemy accounted for by the equant. Thus, Alexandrian astronomy at the very time when the knowledge of it became extinct in the West, and long before the Arabs revived it in the East, was transplanted to India, though not quite in the perfect form in which it was handed down to us by Ptolemy. J L. E. D.

Obituary.

VISCOUNT LEVERHULME OF THE WESTERN ISLES.

THE death on May 7 at the age of seventy-three of Lord Leverhulme deprives the world of a man quite out of the ordinary. Possessed of an amazing vitality, which increased rather than diminished as the years passed, he exerted an influence that will be missed more than a little. For the greater part of his life his activities were confined to the building up of his own business: it is only more recently, with the conduct of the details left in the hands of competent lieutenants, that he has played a part in the affairs of the world at large. Primarily a salesman by nature, Lord Leverhulme had an intimate knowledge of every detail of the soap business; as a designer of a works he can have had few equals—indeed, to play the architect was one of his chief recreations. The great factory at Port Sunlight and the smaller plants which are growing up all over the world will for many years be memorials of this phase of his greatness.

Lord Leverhulme encouraged his technical staff in every possible way to keep abreast, if not ahead, of the times and spent large sums on original research both scientific and technical, himself taking the greatest personal interest in every detail of their progress, as exemplified by his practice of reading and making pertinent comments on every technical report sent to him. He was intensely interested in everything that concerned the betterment of the worker and was one of the very earliest pioneers in what is now coming to be regarded as the science of industrial psychology—the provision of educational facilities for the worker and his children played a large part at Port Sunlight village. Lord Leverhulme had little time to take any active part in higher education, though at times he was a generous patron of the University of Liverpool. His most generous gifts to the nation were latterly connected with art.

Lord Leverhulme was selected to deliver the Messel Lecture of the Society of Chemical Industry at the Liverpool meeting last summer, when he gave an address of prime importance and full of literary charm which in course of time will rank as one of the most remarkable testaments of ideals ever made by an industrialist. The great soap industry with all its ramifications—the Lever Brothers organisation—which he built up, replacing empiricism by science and scientific method, though leaving craft where craft meant quality, is his memorial: he himself would wish for no other.

WE much regret to record the death on March 10, at the age of fifty-six years, of Prof. John F. Hayford, whose passing has been the occasion of appreciative accounts of his life and work in several American scientific journals. John Fillimore Hayford was trained as a civil engineer at Cornell University and was appointed computer to the United States Coast and Geodetic Survey. During this time he served on the International Boundary Commission of the United States and Mexico. In 1895 he went to Cornell University as an instructor in civil engineering, but in 1898 he returned to the Coast and Geodetic Survey, where he remained as inspector of geodetic work and chief of the computing division until 1909. In that year he went to Northwestern University, Illinois, as director of the newly organised College of Engineering. While there he investigated on behalf of the Carnegie Institution of Washington the problem of the surface levels of the Great Lakes and the causes of their fluctuations. Hayford is best known, however, for his computation of the dimensions of the earth, or the Hayford spheroid, based on the theory of isostasy, which was accepted at the recent Madrid meeting of the International Geodetic and Geophysical Union. His work on isostasy was also acknowledged last year by the award of the Victoria Medal of the Royal Geographical Society.

PROF. GUGLIELMO KÖRNER, who died recently in Milan at the age of eighty-six years, was a native of Cassel. After extensive travels in European countries he became professor of chemistry at the Royal High School of Agriculture at Milan, remaining in that capacity for forty years. His work on the constitution of pyridine and quinoline and on the orientation of derivatives of benzene is well known He was the Davy medallist in 1900 of the Royal Society, and an honorary fellow of the Chemical Society.

IN *Naturen* for March is a notice by A. E. Tråen of Dr. Barthold Hansteen Cranner, professor of botany at the Agricultural College in Aas, Norway, who died on February 2, at the age of fifty-eight. Cranner was best known for his work on the biochemistry of the cell-wall in plants.

WE regret to announce the following deaths:

Prof. Albin Haller, For. Mem. R S. and Davy medallist, and honorary fellow of the Chemical Society; director of the Municipal School of Physics and Chemistry in Paris and professor of organic chemistry at the Sorbonne.

Prof. C. D. Woods, director from 1896 until 1920 of the Maine Agricultural Experiment Station, and since then director of information of the Massachusetts Department of Agriculture, who made noteworthy contributions to our knowledge of the nutrition of plants and animals and of foodstuffs generally, on March 30, aged sixty-eight.

Current Topics and Events.

ON Saturday last, May 9, the British Empire Exhibition at Wembley was reopened by the King amid scenes of much popular enthusiasm The King was accompanied by the Queen and was received by the Duke of York, who is president this year of the Exhibition. In his address inviting the King to open the Exhibition, the Duke of York emphasised the many benefits which have resulted from last year's display and stated that, while the Exhibition of 1925 " has integrally the same purpose as in 1924— to show how great are the resources available within the Empire . it will present its lessons of Empire in a new manner " In a happy phrase, he referred to the Exhibition as the " University of Empire " The King congratulated the president, the board of management, and the executive council of the Exhibition on the results of last year's work, and again the educational side was brought out when the King, speaking of the importance of goodwill between the peoples of the British Empire, declared that " the one sure foundation for that goodwill is a full knowledge of our mutual aspirations, capacities, and needs To seek knowledge, more knowledge, and again more knowledge, of the great heritage which has been entrusted to us is the soundest Imperial policy " As last year, the opening ceremony in the Stadium was broadcast from all the stations of the British Broadcasting Company. The general features of the Exhibition will be familiar to most readers of NATURE, and we hope in future issues to deal in detail with specific scientific aspects such as the display illustrating physical and biological science arranged by the Royal Society, the pure chemistry section which the Association of British Manufacturers has organised, and so on

THE Salters' Institute of Industrial Chemistry, which was founded by the Salters' Company to further the interests of industries with which it is historically connected, has now been in existence for seven years, and during this time, under the successive directorships of Dr M O Forster and Prof Arthur Smithells, it has been very successful in assisting the education of those destined for the career of industrial chemistry For the first few years of its existence, the Institute devoted itself to helping students whose chemical training had been interrupted by the War ; now it is following the policy originally laid down, namely, of awarding fellowships, of the normal value of 250-300*l.* per annum, to those who have obtained an honours degree at a university, or the equivalent, and have had a little experience of research ; and of giving grants-in-aid to young men or women employed in chemical works for the purpose of continuing their chemical studies It is interesting to note that in the award of fellowships, academic distinctions and purely mental attainments are not taken as the sole criteria of eligibility. Those conversant with the conditions in industrial works know well how often the academic man fails either because he has little or no power of applying his knowledge, or because he lacks the ability to co-operate with those whose mental or social level is different from his own ; and we wish the Salters' Institute every success in its endeavour to supply the chemical industry with men of character as well as of intellectual attainment.

THE Bolshevik commercial publication in England, the *Soviet Union Review*, in its number for April 25, has published a formidable list of scientific institutions, learned societies, museums, etc., in the R S F.S.R., which means the Russian Soviet Federation of Socialistic Republics, and is the overwhelmingly dominant partner in what is known as the S S S.R., the Soyuz (Union) of Soviet Social Republics, which in turn corresponds to what we have always known as the Russian Empire, though shorn of Finland, the Baltic States, its Polish provinces, and Bessarabia The catalogue includes 21 institutions connected with the Academy of Sciences in Leningrad, 15 physico-mathematical institutions, 12 physico-scientific, 6 biological stations, 7 physico-historical and mathematical research institutes, 4 concerned with political economy and culture research, 4 with scientific research pedagogic institutes, 6 for social study, 11 scientific libraries, 6 scientific societies in Moscow, 9 in Leningrad and 13 in the provinces, 25 regional societies, a substantial catalogue of museums and 6 State Nature preserves. The object is evidently to show the work the Bolsheviks are doing in the arts and sciences, and a certain amount of credit must be granted to Lunacharsky, Commissar of Education, for his protection. But the vast majority of these institutions existed in tsarist days ; only their titles have been altered. Novelties are the institutes for the promotion of Bolshevism, such as the Institute of Red Professors in Moscow, the chair for the study of Marxism at Kazan, and the Marxist Society in Leningrad. The museums have been enormously enriched in material and multiplied in number by the confiscation of private collections and conversion of aristocratic palaces into museums. But the article throws no light upon the efficiency of these institutions. It is known that the serious workers are hampered by incessant interference, and the financial grants, generous enough on paper, are ludicrously inadequate in fact Thus, a grant of 130,000 gold roubles for the maintenance of one of the big scientific institutions was made and properly confirmed, but of this only 3000 roubles reached the treasurer, so that it exists to-day entirely upon the very high admission fees, which the workers of the proletariat have to pay if they want to see the museums Truly, in Russia, " the man who holds the honey-pot licks his fingers," as the Turks say.

ARRANGEMENTS have been made by the American National Geographic Society, in co-operation with the Smithsonian Institution of Washington, to establish a station at some convenient spot for the purpose of making daily observations of the solar constant of radiation over a period of four years. An expedition, of which Dr. C. G. Abbot (director of the Astrophysical Observatory of the Smithsonian Institution)

will be the leader, will be sent out to the station chosen in order to make the necessary observations. Sites in Baluchistan, South-west Africa, and Morocco have already been selected for inspection. The project has arisen as the result of certain conclusions drawn by Dr Abbot and his assistants—from their refined observations of the solar constant for several years past—with regard to the dependence of terrestrial weather on changes in solar radiation It is hoped that the observations will assist in solving the problem of long-range weather forecasting The National Geographic Society has set aside the sum of 55,000 dollars for the purpose of the expedition.

DR. ALES HRDLICKA has left Washington in charge of a survey of the field of early man and his predecessors in Southern Asia, Java, Australia, and Africa by the Smithsonian Institution in co-operation with the Buffalo Society of Natural History The object of the expedition is to examine personally all traces of ancient man and his predecessors in these localities. In India, Dr. Hrdlicka will endeavour to examine all collections of Palæolithic implements as well as all other specimens relating to ancient man and extinct sub-human forms. He expects to visit the Siwalik Hills and also two or more of the most important centres of the non-Aryan Indian population In Java the localities of the finds of the now known representatives of the early man Pithecanthropus will be visited In Australia, Dr Hrdlicka expects to examine the fossil Talgai skull and other skeletal remains of the Australian aborigines In South Africa an effort will be made to visit the sites of the find of the Rhodesian man, of recent finds of fossil anthropoid apes and of prehistoric human skulls preceding the Bushman and Negro.

AN expedition under the leadership of Dr D B Macmillan is leaving for the Arctic regions at the end of June under the auspices of the National Geographic Society of Washington. The first aim of the expedition will be to examine the ruins of the old Norse settlements in Greenland around Julianehaab and Godthaab, comparing these with ruins found on the coast of Labrador. It is hoped by this means to prove or disprove the Norse settlement of Labrador. From Godthaab the expedition will sail for Etah, which should be reached early in August. Here a base will be made for exploration by amphibian aeroplanes of the Greenland ice cap, Ellesmere Land and Grant Land. From Etah, oil and other supplies will be carried by air to a second base at Cape Thomas Hubbard on the north of Axel Heibergland, a distance of about two hundred and fifty miles. This base will be used for an aeroplane reconnaissance of the unexplored area of the Arctic Ocean lying between the Canadian Arctic Archipelago and the New Siberia Islands. The distance to the centre of this unknown area is about six hundred miles, and Dr. Macmillan hopes to cover the double journey in a continuous flight. If any islands are discovered, a landing will be made. On the completion of this ambitious programme in the north, the expedition will go southward along the eastern shores of Ellesmere Land to Bylot Island, which will serve as a base for the aeroplane exploration of Baffin Land. Lastly, Nachvak Bay will serve as a base for flights over northern Labrador. Meteorological observations of the upper air will be taken during all the flights It is expected that the expedition will be away until the autumn.

A COMMUNICATION in the *Times* of April 28 describes investigations carried out last year by Prof Hrozny in Syria and Asia Minor with the object of throwing light on Hittite problems Prof Hrozny, who is well known to scholars for his researches in the Hittite language, which led to the discovery of its Indo-European affinities, has planned a series of excavations on sites on the borders of the Hittite Empire in the hope that the discovery of a bilingual inscription may lead to the decipherment of the Hittite pictographic script Excavations at Sheik Sa'ad in Bashan near the monolith of Rameses, called by the neighbouring inhabitants "the Stone of Job," revealed an Amorite shrine of a deity Arkan Saphon, which was the centre of a widespread cult. This cult, as was shown by the later Hellenistic shrine, was adopted by the Greeks It was surrounded by a number of edifices and remains ranging from the Hittite period in the Second Millennium B C down to the Roman times It is clear that the inhabitants were Amorites who were affected by Hittite culture, and possibly under Hittite rule The site may mark the frontier of the Hittite Empire A projected excavation at Kaisarieh in Anatolia could not be carried out, but the hitherto unknown source of the well-known Cappadocian tablets was identified at Kul Tepe.

DR H H DALE, in his discourse at the Royal Institution on May 8, on the circulation of blood in the capillary vessels, said that about the year 1917 evidence from several independent quarters began to appear, necessitating an extensive revision of the older conception of the capillaries as playing a purely passive rôle in the regulation of the blood flow Ebbecke in Germany, and Lewis and his co-workers in Britain, began to publish evidence that the capillaries are capable of closing completely by their own contractile force. In the following year Krogh, of Copenhagen, showed that, in the muscles at rest, only a very small part of the rich network of capillary vessels is open for the passage of blood, the remainder being completely closed by their own contractile tone Meanwhile similar conclusions had been reached by another independent group of investigators, including Dr Dale, who were studying the collapse of the circulation produced by a group of substances resulting from the decomposition of proteins, a typical member being the base histamine. Such substances caused relaxation of the peripheral blood vessels, apparently largely of the capillaries. When the effect was intense, a large part of the blood passed out of circulation, becoming stagnant in the generally relaxed capillary vessels, and losing a large part of its plasma through their permeable walls. The deduction was made, and almost immediately

confirmed by Krogh's direct observations, that the capillaries possess a power of independent contraction, by which a large proportion of them are normally closed. These conceptions have acquired increasing importance, not only for the understanding of the fine adjustment of the blood-flow to the varying metabolic needs of the tissues, but also in explaining a number of pathological conditions, where, as the result of massive injury of the tissues, or of the invasion of the body by bacteria, poisonous protein derivatives are distributed in the circulation producing in a generalised and dangerous form a relaxation of the capillary vessels, which, in the form of a localised inflammation, is protective and restorative There is evidence that the internal secretions of the suprarenal and pituitary glands have an important effect on the tone of the capillary vessels.

THE first Fison Memorial Lecture was delivered by Sir Joseph Thomson in the Medical School, Guy's Hospital, London, on Thursday, May 7, the chair being taken by Lord Balfour. Sir Joseph selected as his subject "The Structure of Light," in the course of which he stated that the optical properties of light appear to be explicable only upon a wave theory, whereas the electrical properties are more easily explained on a corpuscular theory. Newton himself really combined the two theories, as the assumption of waves generated by the corpuscles was an essential part of his explanation of simultaneous reflection and refraction. The followers of Newton were "more corpuscular" than Newton himself, and a purely corpuscular theory of light was generally adopted until the work of Young and Fresnel once more focussed attention upon the wave theory. By the end of the nineteenth century, Maxwell's electromagnetic theory, and the pioneer experiments of Hertz and Lodge on electromagnetic waves, had made the wave theory of light probably the most complete and satisfactory in physical science. Then the study of gaseous ionisation, the photo-electric effect, X-rays and black body radiation, began to throw doubts upon the sufficiency of the ordinary wave theory

As an alternative, Sir Joseph Thomson put forward a new theory designed to explain both electrical and optical properties of light (see *Phil. Mag.*, vol. 48 (1924), p 737). Imagine an electron and a positive nucleus joined by a tube of force. If the electron jumps from one stable state to another of smaller energy, we may suppose that the tube of force is thrown into a loop, which becomes detached as a closed "ring of force" Such a ring would travel out like a vortex ring in a direction perpendicular to its own plane It would also carry with it a definite "quantum" of energy. Immediately before and after the formation of the ring ordinary electromagnetic waves would also be started, but the ring would carry nearly all the energy liberated by the movement of the electron. Absorption of energy by an atom could take place by a converse process, and would normally occur only when the energy in the ring was sufficient to move an electron from one stable state to another, *i.e.* when the energy was great enough to produce partial or complete ionisation of the atom. The circumference of a ring of force would be equal to the wave-length of the light, and so a ring of visible light would be too large to be absorbed easily by an atom except by a process involving resonance, whereas an X-ray ring would be comparable in size to an atom This would account for the observed differences between X-ray and optical absorption. The waves which accompany the ring would undergo interference and diffraction, and the rings would tend to follow the waves, so that the probability of a ring reaching a given point would depend upon the amplitude of the wave at that point. Thus interference and diffraction fringes would be statistical effects.

THE eighth lecture of the series on "Physics in Industry" being given under the auspices of the Institute of Physics was delivered by Dr. W. Makower on April 29 and dealt with "Physics in the Rubber Industry with special reference to Tyre Manufacture." In this industry there are many stages where the skilled assistance of the physicist has proved valuable in improving the product or in reducing costs. In testing the raw material, hardness is the decisive quality and this is determined by viscosity measurements, made by forcing the rubber at a constant temperature of 80° C through an orifice and measuring the rate of flow. In all properties related to hardness, temperature is a most important factor. Thus, rubber must be stored at a low temperature and processes such as calendering and rolling must be carried out at constant temperatures, to which end thermocouples are now used extensively. To measure the physical effects of addition agents on hardness, it is usual to construct stress-strain diagrams In vulcanisation, physical control is used in determining the amount of sulphur absorbed at different depths of the tyre, thermocouples being embedded in it and the temperature attained noted. The way the tyre is built up will determine largely its ultimate strength, which is found chiefly to depend upon that of the cotton case. Other necessary tests are for fatigue and abrasion, and these have to be so designed as to imitate the effects of actual practice. Of great interest are the hysteresis heat losses, which may amount to one-half to one H.P. per tyre. These depend upon the deformation of the rubber as well as on the rate of application of the cyclical stresses. In this connexion, Dr. Makower pleaded for closer co-operation between tyre manufacturers and automobile engineers so that there may be careful adjustment between springs and tyre equipment.

BROADCASTING reception in Great Britain is by no means confined to the programmes transmitted by stations in this country, and a number of continental stations can now be easily received. The Oslo station is the most recent addition, and the number will soon be increased by transmission from Stockholm and Madrid, when the stations which are now in course of erection by Marconi's Wireless Telegraph Co., Ltd., are completed. The new stations are

Standard Marconi 6 kw. Type "Q" stations, similar to those of the British Broadcasting Company's main stations. The transmitter consists essentially of four panels; rectifier; independent drive, main oscillator and modulator. The use of the independent drive in the Marconi transmitters ensures the invariability of the carrier wave frequency, with consequent absence of alteration of tuning adjustments at the receiver. One of the features of transmissions from the Oslo station so far as British reception is concerned, appears to be the absence of fading. The aerial is supported by two lattice steel masts 70 feet high and is a "T" type of four-wire cage aerial, with a span of 150 feet. The Oslo station has avoided causing interference with other European broadcasting stations by using the wave-length of 382 5 metres.

THE twelfth International Physiological Congress will be held in 1926, at Stockholm, on August 3-6. The Congress will be under the presidency of Prof. Johansson. Prof. Liljestrand will be honorary secretary, and Prof Santesson honorary treasurer.

THE Lawes Agricultural Trust Committee has appointed as its chairman Lord Clinton, in succession to Lord Bledisloe, who resigned on accepting the post of Parliamentary Secretary to the Ministry of Agriculture and Deputy Minister of Fisheries.

DR. EMILE BRUMPT, professor of the Faculty of Medicine of the University of Paris, will deliver two Chadwick Public Lectures, on May 25 at the Barnes Hall of the Royal Society of Medicine on "How to conduct an Anti-Malarial Campaign," and on May 29 at the Royal Society of Arts on "The Prophylaxis of Sleeping Sickness"

DR. E. F. ARMSTRONG, F R.S., technical director of Joseph Crosfield and Sons' Soapworks at Warrington, has been appointed managing director of the British Dyestuffs Corporation. Dr. Armstrong, who was president of the Society of Chemical Industry in 1922–24, is well known for his work on the chemistry of plant products and on the nature of enzymes; he has also made noteworthy contributions to the study of catalysis. His work covers a wide field in both pure and applied chemistry, and together with his administrative experience, eminently qualify him for the important post which he has now accepted.

THE Council of the Royal Society of Edinburgh has made the following awards:—The Gunning Victoria Jubilee Prize for the period 1920–1924, to Sir Joseph Thomson, in recognition of his great discoveries in physical science; and the Makdougall-Brisbane Prize for the periods 1920–1924, to Prof. H. Stanley Allen, for his papers on the quantum and atomic theory, published in the Society's Proceedings within the periods.

THE Council of the Institution of Electrical Engineers has made the following award of premiums for papers read during the session 1924–25, or accepted for publication:—*The Institution Premium*: Mr. H. W. Clothier. *Ayrton Premium*: Major E. I. David. *Fahie Premium*: Col. T. F. Purves. *John Hopkinson Premium*: Mr. G. Rogers. *Kelvin Premium*: Lieut.-Col. K. G. Maxwell and Mr. A. Monkhouse. *Paris Premium*: Mr. D Murray. *Extra Premiums*: Messrs. J. D. Cockcroft, R T. Coe, J A. Tyacke, Prof. Miles Walker, and Mr. S. Holmes. *Wireless Premiums*: Major A. G Lee and Mr. A. J. Gill, Capt. H. J Round and Messrs. T. L. Eckersley, K. Tremellen, and F. C. Lunnon; Prof E. Mallett and Mr. A. D. Blumlein; and Mr L. C. Pocock.

PROF. T. C. CHAMBERLIN, of Chicago, has been awarded the first Penrose Medal of the American Society of Economic Geologists The Medal, which is to be given once in three years for "exceptionally original work in the earth sciences," was established by Dr. R. A. F. Penrose, jun., first president of the Society of Economic Geologists, and is of gold We learn from *Science* that in making the award, Prof. Kemp, president of the Society, referred in particular to Prof. Chamberlin's work on the lead and zinc ores of the Upper Mississippi Valley, and to his contributions on the Ice Age, on the planetesimal hypothesis and related topics, and on diastrophism as a principle in the subdivision of geological time.

WING COMMANDER HAROLD E. WHITTINGHAM has been awarded the Chadwick Gold Medal and 100*l* prize for his work on sand-fly fever. The award is made under the provisions of the Chadwick Trust, whereby the Trustees may, once in every five years, present the sum of 100*l* and a Gold Medal to be called the Chadwick Naval, Military or Air Force Prize to such officer of the Navy, Army or Air Force Medical Service as shall during the preceding five years have "specially assisted in promoting the health of the men" of the Service to which he belongs

A CONFERENCE of women in science and industry at the British Empire Exhibition, Wembley, on July 15–17, has been convened by the Women's Engineering Society in co-operation with the British Federation of University Women, Industrial Welfare Society, Institute of Industrial Welfare Workers, The National Union of Scientific Workers, The Standing Joint Committee of Industrial Women's Organisations and the Women's Electrical Association. H.R.H the Duchess of York has consented to become president of the conference, and amongst those speaking on the opening day will be: The Hon. Lady Parsons (Engineering), and Miss Ellen Wilkinson, M.P. (Industrial Organisation). The following two days will be devoted to papers by women workers on such subjects as engineering, chemistry, industrial welfare, factory inspection and commerce. Particulars can be obtained from the Secretary, Women's Engineering Society, 26 George Street, Hanover Square, London, W.1.

A PRELIMINARY meeting of the International Congress of Radiology will be held at the Central Hall, Westminster, on July 1-4, under the presidency of Mr. C. Thurstan Holland. The Congress will meet in three sections: (1) radiology; (2) electrotherapy and physiotherapy; and (3) physics. During the meeting there will be an exhibition of apparatus and books at the Central Hall, Westminster, and an exhibition of radiograms in the British Institute of Radiology, including those relating to papers read at the Congress.

On July 1 the Duc de Broglie will deliver the Silvanus Thompson Memorial Lecture, and on July 3 Sir Berkeley Moynihan will deliver the Mackenzie Davidson Memorial Lecture, taking as his subject "The Relationship of Radiology and Surgery." Communications regarding the Congress should be addressed to the Secretaries, International Congress of Radiology, c/o British Institute of Radiology, 32 Welbeck Street, London, W.1.

FOR its May meeting the Society of Glass Technology has arranged a symposium of papers on the constitution of glass, to which a number of important contributions have been promised. Two sessions will be held, the first at 7.30 P.M. on Monday, May 25, at the Royal Society of Arts, John Street, Adelphi, London, and the second on Tuesday, May 26, at 2.30 P.M., in the Chemistry Lecture Theatre, University College, Gower Street, London. Papers have been promised by Prof. W. E. S. Turner (Sheffield), Prof. G. Tammann (Göttingen), Dr. F. Eckert (Essen), Dr. A. Q. Tool and E. E. Hill (Bureau of Standards, U.S.A.), Prof. Le H. Chatelier (Paris), Sir William Bragg (Royal Institution, London), Mr. V. H. Stott (National Physical Laboratory, Teddington), Dr. G. W. Morey and Dr. N. L. Bowen (Geophysical Laboratory, Washington), Dr. A. A. Lebedeff (Optical Institute, Leningrad), Dr. G. W. Morey and Dr. R. W. G. Wyckoff (Geophysical Laboratory, Washington). Members of the Faraday Society, the Optical Society, the Physical Society, and others interested in the subjects of discussion are invited to be present.

WE welcome the appearance of the opening part of the *Japanese Journal of Mathematics*, which is announced to appear quarterly, sponsored by the National Research Council of Japan. Ninety-three pages of Transactions contain 16 papers (of which 14 are in English and 2 in German), all in pure mathematics and nearly all on the higher analysis. There follow 12 pages of English abstracts of recent mathematical papers published in other Japanese journals. This new venture, together with similar publications already in existence or promised, covering such subjects as astronomy and geophysics, chemistry, physics, geology and geography, botany, zoology, medical science, and engineering, are likely to enhance the quality of scientific research in Japan; and if they are well distributed they cannot fail to improve the status of Japanese work in the world of science.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: an assistant in mathematics in the Queen's University, Belfast—Prof. Dixon, the University; a lecturer in agriculture at Armstrong College, Newcastle-upon-Tyne—The Registrar; a laboratory assistant in the agricultural department of the Government of Kenya—The Crown Agents for the Colonies, 4 Millbank, S.W.1; two zoologists for the *Discovery* Expedition—The Secretary, *Discovery* Committee, Colonial Office, Downing Street, S.W.1 (May 25); a junior assistant under the directorate of explosives research of the research department, Woolwich—The Chief Superintendent, Research Department, Woolwich; a biology teacher, either sex, at the Municipal Secondary School, Wolverhampton—The Director of Education, Education Offices, Wolverhampton (May 30); full-time lecturers in biology and mathematics at the Technical College, Cardiff—The Principal (May 30).

Our Astronomical Column.

COMETS AND MINOR PLANETS.—Dr. W. H. Steavenson obtained an observation of Orkisz's Comet on May 6d 0h 1m, G.M.T. (new), R.A. 23h 15m 26·12s, N. Decl. 55° 14′ 53·9″, equinox 1925·0. The comet was of magnitude 7·5 and growing slightly fainter.

Owing to its high north declination it is observable all night.

EPHEMERIS FOR 0h (by Möller and Johannsen)

	R.A.	N. Decl.	log r.	log Δ
May 15.	23h 51m 4s	67° 25′		
19	0 18 23	72 24	0·129	0·184
23.	1 1 31	76 51		
27	2 14 57	80 23	0·152	0·206
31.	4 12 18	82 11		
June 4	6 18 19	81 36	0·175	0·235

EPHEMERIS FOR 0h OF COMET SCHAIN, COMAS SOLA (by H. Kobold).

	R.A.	N. Decl.	log Δ.
May 16	10h 31m 45s	4° 28′	
20	10 28 27	4 29	0·604
24	10 25 30	4 30	
28.	10 22 54	4 29	0·619
June 1	10 20 36	4 26	
5	10 18 37	4 22	0·634

It is of magnitude 12 and slowly fading.

Astr. Nach., No. 5365, contains an important series of observations of planet TD (the interesting object discovered last October by Baade, the period of which is 4·36 years), made by G. Struve at Berlin Babelsberg, extending from November to March 3, when its magnitude was 13·0.

No. 5366 contains observations by J. Hartmann from April to July 1924 of the planet RK, which he discovered last year. Its period is five years and its eccentricity is very small. He has given it the name La Plata, after the town where it was discovered.

GRAVITATIONAL FORCES IN SPIRAL NEBULÆ.—Prof. Ernest Brown contributes a paper on this subject to the *Astrophysical Journal* for March. His aim is to see whether the observed motions can be explained without the assumption of non-gravitational forces such as those suggested by Dr. Jeans's investigations. He first analyses the motions given by Mr. van Maanen, and shows that these are by no means uniformly outward, though the latter direction predominates at points where the spiral arms are well defined. The angular velocities diminish rapidly at first, and then become nearly constant, indicating a force varying as the distance from the centre; this would be the law of force in the equatorial plane of an ellipsoid of uniform density for a particle within the ellipsoid. The suggestion is, therefore, that there is considerable concentration at the centre, and outside this an extended ellipsoid of low and nearly constant density. The orbits of the constituent particles are supposed to fall into groups of which the "arms" of the spiral are envelopes. The space density is of the order of 10^{-18} of that of the sun; this gives masses of the order of 10^9 times the sun, assuming a parallax of 0·001″, which is, however, much larger than that indicated by the recent researches of Hubble.

Research Items.

THE SEQUENCE OF TYPES IN STONE IMPLEMENTS IN RHODESIA.—Stone implements in South Africa exhibit two definitely demarcated periods of human habitation, one characterised by hand axes of Chellean or Acheulean type, the other by flake implements of Aurignacian facies. In many localities the hand axes are associated with flakes, some showing unmistakable evidence of design and secondary chipping, but there is no evidence whether they indicate two distinct periods. Mr Neville Jones, in vol. 54 of the Journal of the Royal Anthropological Institute, describes implements from Sawmills, Rhodesia, showing two distinct periods of human activity which can be differentiated by geological evidence. This is the only site in Rhodesia as yet known on which this is possible. Hand axes of pointed and oval form are found in a bed of coarse gravel on rising ground near the Umguza River. A lower terrace resting on alluvium and largely derived from the older terrace is the site of a factory of implements made from flakes struck from pebbles of various forms of silica. Most are worked on one side only, and show an exquisitely fine retouch. By some it is thought that these latter are the work of early Bushmen, though, as a rule, Bushmen implements are smaller and lack the same definiteness in form.

THE ORIGIN OF AMERICAN MAN.—In the *Quarterly Review* for April, Mr Lewis Spence surveys and discusses the evidence bearing upon the origin and antiquity of man in America. His conclusion is that the New World received its main human stock from Asia at a period when the Eastern portion of that Continent had developed only a slender degree of culture at the closing stages of the glacial period or possibly at one of the recurring intervals of mildness, but there were later accessions. European influence, apart from the Norsemen, may be seen in the banner stones and the stone gouge of New England and farther north, and there is also the tradition of Madoc's expedition from Wales. The architectural remains of Central America and south-eastern Asia present close similarities in certain features, though the correlation of Mayan dating with our system precludes influence much later than two thousand years ago. The cult of Quetzalcoatl in his earlier forms exhibits analogies to Buddhism. Polynesian influences have been discerned in several customs and forms of artistic endeavour in South America. The extreme view of the entirely indigenous origin of American culture is untenable, but America probably was visited by a number of bands or units who brought with them the knowledge of an alien culture which only partially affected that of the older settlers from north-eastern Asia.

RUSSIAN INVESTIGATIONS OF THE FAUNA OF ASIA.—While expeditions of the American Museum of Natural History have been for several years exploring the past and present fauna of Mongolia, where, apparently, a large proportion of Palæarctic forms originated, the same problems have been attacked by Russian workers from the north. Prof. P. P. Sushkin made a study of the fauna of Altai mountains and of northern Mongolia during his expeditions in 1912 and 1914, results of which were so rich that he has only recently been able to arrive at some conclusions published in the recent issue of the *Comptes rendus* of the Russian Academy of Sciences. An analysis of the present ornithological fauna, in connexion with the geological history of the country, enables P. P. Sushkin to reconstruct the history of the fauna in the following way. In the palæolithic, the Eastern, or Trans-Yenissean, Siberia formed a continuous mass of land together with Mongolia (the Angara-continent of geologists), while western Siberia was covered by sea. The ancient endemic elements which are numerous in the eastern Siberian fauna are relics of the Angara fauna. The fauna of western Siberia is very poor in endemics, and it bears, on the whole, European characters, this results from the fact that the country became dry land only at the beginning of the neolithic, when it was populated by the animals driven from Europe by the glaciation, which began in Europe earlier than in Siberia. The glacial period in Siberia was followed by a dry and hot period when steppes and deserts extended very far to the north. After the desert period came a more moist one, continued until the present time, and it resulted in the extensive development of forests which have driven the steppe and desert forms southwards, while a few desert "islands" remained surrounded by forests. Prof. Sushkin is at present in the United States completing his studies and comparing his results with those attained by the American zoologists, he is also making arrangements for publication in English of his results in book form.

DIMORPHISM IN EARWIGS.—Ever since the work of Bateson and Brindley on the length of the forceps in the common earwig, Forficula, this has been quoted as a typical case of dimorphic variability. In a posthumous paper D. M. Diakonov (*Journ. Genetics*, vol. 15, No. 2) has made an elaborate experimental and biometric study of this dimorphism, from Russian specimens living under the bark of tree-stumps. The dimorphic condition is confined to the males, and is known in several species. Other features of body-size vary continuously, but there is some correlation between body-size and length of forceps. The relative frequency of the two types, *brachylabia* and *macrolabia*, varies greatly with the conditions, and there is other evidence that these modes or types are non-inherited modifications. Under unfavourable conditions, a larger number of *brachylabia* occurs. The reaction-norm is not a linear but a more complex function of the environmental conditions. Various similar cases in plants, such as the *Zwischenrassen* of de Vries, are cited.

GOLGI APPARATUS.—In a summary account of the form and function of the Golgi bodies in cells, Mr Leslie A. Harvey (*Sci. Progress*, April 1925) points out that they have now been found in practically all vertebrate tissues, and also in many tissues of invertebrates and plants. First discovered in 1898 in vertebrate ganglion cells, the demonstration of this apparatus in cells has resulted from the fact that it reduces osmic acid, and can be impregnated with silver salts—a technique developed by Cajal, Da Fano, Kopsch, and others. In many tissues it takes the form of a network of threads, but in invertebrates it is in rods or vesicles, and it has been seen in the living cell. It takes various other forms, and there is much evidence that it is concerned in secretion. Its history has also been traced in spermatogenesis, and it is believed to have a lipoid constitution. It is suggested that in the living cell it exists in the form of a system of vesicles each surrounded by a fluid membrane.

THE VOLCANIC ROCKS OF BANKS PENINSULA.—A petrographic and chemical study of these interesting New Zealand rocks has been carried out by R. Speight, and is described in the Records of the

Canterbury Museum, N.Z., vol. 2, No. 4. Most of the rocks present features which make their nomenclature and classification a matter of difficulty. According to the silica percentage they would be called basalts, and by some petrologists this classification would be confirmed by the usual presence of olivine. On the other hand, the ratio of felsic to mafic minerals would lead other authors to regard them as andesites. The plagioclase rarely affords a conclusive test, as the phenocrysts are frequently labradorite, while the groundmass felspars are oligoclase. Petrologically, however, the rocks are much more closely related to the basalts of the Pacific Islands and the Brito-Arctic region than to the typical andesites of the circum-Pacific belt. This is shown by the high percentage of titanium dioxide and the generally under-saturated character of the lavas, and is confirmed by the association of dykes of trachyte and trachytoid phonolites. The succession of magmas in the region appears to be as follows: (*a*) rhyolites and andesites of Cretaceous age (these being Andean in type, and not referred to above); (*b*) olivine "andesites" and basalts of Middle Tertiary age; (*c*) dykes of trachyte and dolerite, nearly contemporaneous with (*b*); and finally (*d*) basalts, of which some are definitely alkaline, of late Tertiary or early Pleistocene age.

Evaporation and Temperature Changes in the English Channel.—A paper by Mr. H. W. Harvey in the March number of the Journal of the Marine Biological Association describes a series of observations of temperature and salinity of the sea carried out since April 1921, at a station 20 miles south-west of Plymouth, where the depth is 70 metres. There was an inflow into the area surrounding the station of warm highly saline water during 1921, after which there have been no marked movements of water, but an irregular decrease in salinity. A diagram shows the monthly averages of the mean temperature of the whole column from top to bottom. The yearly minimum occurs in each year in March, and the maximum in September or October. From the changes of temperature from month to month is derived the net daily loss or gain of heat of a column of 0·1 square cm. cross section. From this and the solar radiation recorded at South Kensington, a calculation is made of the difference between the net gain or loss of heat and the incoming radiation. This difference is attributed to evaporation. The result arrived at is that the water gains heat from the spring to the autumn equinox, and loses heat from the autumn to the spring equinox, and that the loss by evaporation overshadows the loss by radiation, the loss due to direct heating of the atmosphere being relatively small. It is concluded that the changes in temperature of the sea were controlled to a marked extent by evaporation. A very interesting observation was that, in the absence of windy weather and consequent mixing by waves, the upper layers may be heated by solar radiation in early May, giving a shallow warm layer separated from the cold water below by a sharp surface of discontinuity. Several days of rough sea are necessary to disturb materially this distribution of temperature. It is also pointed out that in fine clear weather with only light winds the upper inch or two of water become very hot. The normal method of sampling sea water in a bucket represents the surface 6 inches, more or less, so that the sample is considerably cooler than the actual surface temperature of the sea. The records discussed appear to show that there is no correlation between wind during the month and either the fall in temperature or the loss of heat due to evaporation, and it is concluded that, in the open sea, vapour pressure is the major factor controlling evaporation, and overshadows the effect of wind. It is possible that a clearer relation between wind and evaporation might have been obtained if the observations had been discussed in two separate classes, according as the air is warmer or colder than the sea surface.

Modern Colour Problems.—In recent years, considerable attention has been directed to the problems involved in the perception and measurement of colour. The solution of these problems is not only a matter of academic interest, but is also of considerable practical importance. In the series of Cantor Lectures, delivered before the Royal Society of Arts on November 24 and December 1 and 8, 1924, and recently published in the Society's Journal, Dr. L. C. Martin gave a critical review of the present position of colour theory and standardisation. The selective effects of transmitting and reflecting materials were discussed, and the early attempts to produce artificial daylight described. Modern developments in this direction have resulted in the production of corrected units which, when properly applied, are fairly satisfactory and efficient for most of the requirements of commerce and industry. An interesting fact in this connexion is that retinal reflex actions exercise an important influence in enhancing visual sensitiveness and discrimination. Since the reflex action is much greater at the violet than at the red end of the spectrum, the deficiency in the violet in artificial daylight may result in a relative diminution of retinal sensitiveness, and therefore a somewhat greater intensity than is necessary in the case of real daylight may be called for if the same facility in colour matching is to be attained. In the third lecture of the series, the various methods of colorimetric measurement were described. In this branch of the subject rapid advances are being made. The study of the action of the visual receptor mechanism, its fatigue, adaptation and response characteristics, is placing the operations of photometry and colorimetry on a new and sounder basis. For the development of the more utilitarian applications of colour measurement, further study is required of the phenomenon of diffuse reflection and of the transmission and scattering of light in relation to the measurement of the surface colours of material objects.

Effect of Alternating Magnetism on Hæmatite.—A lecture given by Mr. W. M. Mordey to the Royal Institution on May 18, 1923, on "Some New Effects of Alternating Magnetism" has just been published. Mr. Mordey discusses the anomalous behaviour of specular hæmatite, a black crystalline form of ferric oxide in the form of powder, when placed in an alternating magnetic field and in a rotary magnetic field. On sprinkling iron filings on a glass plate placed over an alternating current magnetic pole, the filings lie on radial lines of force proceeding from a point. When, however, specular hæmatite is sprinkled on the plate a very small amount of the material is attracted to the pole, but most of it is repelled briskly in all radial directions, forming a large ring round the pole. On slightly raising the plate the small amount of attracted material is repelled to the other particles forming the ring. The particles when in a very strong field are attracted, but when in a weaker field are repelled from the pole. For a certain strength of field there appears to be neither attraction nor repulsion. The phenomenon is analogous to the electrostatic actions which take

place between two conductors having unequal but like charges of electricity. In this case, as Snow Harris showed many years ago, they attract one another when close together, but repel one another when they are far apart, the neutral position where neither attraction nor repulsion takes place being well defined If a heap of the ore containing the hæmatite be placed on the glass plate, then the hæmatite is driven out of the heap and deposited in the feebly magnetic regions, leaving the inert material behind. When polyphase magnets are used, we get rotary magnetic fields produced, and the motions of the particles become much more complicated, especially those which exhibit strong magnetic hysteresis The field is an inviting one for experimenters, but there are too many variables in it to make it attractive to the theoretical physicist.

ZIRCONIUM ORES —The examination of a large number of zirconium ores, described by G Hevesy and V T Jantzen in the *Chemical News* for March 20, shows that there is no connexion between density and hafnium content, whereas there is a rough relationship between the latter and the radioactivity. In minerals of nepheline syenitic origin (*i.e* products of alkaline residual crystallisation) the ratio HfO_2/ZrO_2 is about 0 015 ; in minerals of granitic origin this ratio is probably about 0 03

LUMINOUS PAINTS —An article on luminous paints and enamels is published in the *Chemical Trade Journal* for March 27 In the latter part of the sixteenth century, Vincenzo Cascariolo, a cobbler and alchemist of Bologna, experimented with some specimens of heavy spar which he obtained at Monte Paterno On calcining the mineral with charcoal he obtained a substance " which absorbed the rays of the sun by day and emitted them by night " This power is shown by sulphides of barium, calcium, strontium, magnesium, zinc and other metals, though the actual cause of the phosphorescence is apparently the presence of minute quantities of certain impurities, which govern the colour of the glow, and in the absence of which no luminescence is observed Highly luminous products, suitable for practical use, are now obtained by heating mixtures of alkaline earth oxides or carbonates with sulphur, to which small quantities of lithium carbonate, and in addition traces of bismuth nitrate, rubidium nitrate, lead acetate or other metallic salts, have been added This addition is usually made in the form of a standard alcoholic solution. The article describes the manufacture of typical luminous bodies and gives several formulæ. The effective life of such substances and their practical applications are considered in full detail.

CADMIUM.—Dr. N. F. Budgen describes the production and commercial uses of cadmium in an article in the *Chemical Age* for March 7. The metal was first isolated in Stromeyer's laboratory from the oxide (1818) ; several names were proposed for it (*e g* melinum), but the present name, suggested by Stromeyer, was finally adopted. Cadmium is always found associated with zinc in its ores, but more recently lead and copper ores containing considerable amounts of the metal have been found. Cadmium can only be profitably produced as a by-product in the treatment of ore for the main metal; the cadmium always concentrates in the flue-dusts, condensed fumes, etc., and it is obtained from these either by direct distillation or by solution followed by chemical or electrolytic precipitation. The chemical properties of cadmium are described in detail and a good account of the uses of the metal in alloys is given " Stain-resisting " silver contains cadmium. The electro-deposition of the metal and its alloys is also described.

DECAY AND PRESERVATION OF STONE —The decay of stone and preservation of buildings are the subjects of a paper by Dr A P Laurie in the Journal of the Society of Chemical Industry for February 27 The rapid disintegration of stone is caused mainly by the formation of calcium sulphate crystals within it, which by persistent growth in certain layers or pockets ultimately break up the stone Analyses of decaying stone from various cathedrals show, however, that a stone can carry considerable quantities of calcium sulphate without breaking up The results of experiments described in the paper lead the author to propose a complete change of policy with regard to our public buildings He suggests they should be washed down three or four times in summer so as to ensure rapid evaporation. The purpose of this is to help the rain to dissolve out as much calcium sulphate as possible A new cement for repairing decaying stonework is mentioned, namely, " silicon ester," prepared by the action of alcohol on silicon tetrachloride When exposed to air and moisture it deposits transparent silica It is suggested that sandstone with a binding material of silica is most suitable for buildings in modern cities

GAS TURBINES —In a recent paper before the N E. Coast Institution of Engineers and Shipbuilders, Mr M Konig surveys the attempts to produce a gas turbine and gives an interesting account of current work on this difficult problem A gas turbine might compare favourably with an internal combustion engine of the ordinary reciprocating kind by an improvement in thermal economy, by a reduction in weight per horse-power, or by a reduction in harmful vibration but in the author's view the temperatures required for high efficiency are beyond the capabilities of materials at present available, and it is only for certain specialised purposes that the second and third possible merits are of importance. Holzwarth's work on the gas turbine has for long been a source of interest to English engineers, but little was known of details of the progress which had been made Mr Konig quotes over-all efficiencies of 16 8 and 17 8 per cent. for the Holzwarth 300 kw. and 700 kw turbines respectively, and states that a large unit of 5000 kw at 1000 r p m has been built and is now ready for testing. This large unit has a single turbine wheel of 10 ft in diameter and 12 tons in weight The maximum gas temperature is given as " almost 3000 deg F." The field in which the gas turbine has won its way already to the front is in the compounding of the petrol engine used in aircraft by the employment of an exhaust turbine to pump air into the engine intake and so overcome the disadvantage of diminution in atmospheric pressure at altitude. It is stated, for example, that in January 1924 the General Electric Company of America gave particulars of such a supercharger turbine which ran at 33,000 to 41,000 r p.m and fed its engine, when the aircraft was at 35,000 ft. altitude, with air at sea-level pressure. The weight of this turbine plant is given as 140 lb and the additional power delivered under these conditions by the engine as 280 h.p. The author points out that this aeronautical development may lead the way to progress in other fields, and he instances the work being undertaken in this direction by Brown, Boveri and Co., by the English Electric Co., and by the Curtis Gas Turbine Co. of America

Recent Researches in Positive Rays.[1]

PROF. W WIEN, in delivering the tenth Guthrie Lecture to the Physical Society, described the researches on positive rays carried out in his laboratory at Würzburg, passing over the subject of isotopes, as worked out in England, on the ground that this was already familiar to British audiences

Prof. Wien dealt mainly with the determination of the mean free paths appropriate to the various states of the particles composing the positive or canal rays Such a particle is alternately in the charged state, owing to loss of an electron by collision, and in the uncharged state, owing to the recapture of an electron in a further collision The mean free path in the first state being denoted by L_1, in the second by L_2, the first problem attacked was the determination of the ratio L_1/L_2 It is not difficult to show that this is equal to n_1/n_2, where n_1, n_2, are the respective numbers of charged and uncharged particles composing the stream ; and it is found that n_1 is less than n_2

In the first apparatus employed, a narrow pencil of canal rays has to run the gauntlet of a series of ten condensers 1 cm. wide and separated each from its neighbour by a distance of 1 mm , the plates of each condenser being also 1 mm apart These ten condensers are arranged side by side in a line and the pencil of rays passes between each pair of plates in turn and finally strikes a thermopile, which thus measures the kinetic energy of the aggregate of particles falling upon it , and when the condensers are short-circuited, this energy is the sum of those of the charged and of the uncharged particles When, however a potential difference is established between the plates of the condensers, a diminution is observed in the thermopile reading in consequence of the elimination of some of the charged particles, and as the potential difference is increased this reading approaches a constant value which gives the energy of the uncharged particles alone From these data the ratio of L_1 to L_2 can be calculated

If now the pencil of canal rays be entirely freed from charged particles by the first condenser, the remaining uncharged particles continue the process of acquiring and losing charges after they have passed away from that condenser, and a fresh determination similar to that just described can be made by charging a further one of the ten condensers, in addition to the first It is then found that the ratio of L_1 to L_2 for this (initially uncharged) beam depends on the distance between the two charged condensers, and in this way L_2 itself can be found

In the investigation just described the pencil of positive rays consisted of particles of very mixed velocities and chemical character Ruchart, however, afterwards employed a tube made in two parts with a universally swivelling joint, and spread the pencil out into parabolic sheets by applying simultaneous electric and magnetic fields Particles of a particular velocity and chemical character were selected by means of slits, and the selection could be varied by relative movement of the two parts of the tube. The measurements already described were then repeated with the homogeneous pencils obtained. If the reciprocal of L_2 as thus found be plotted against the pressure in the tube, the resulting graph is a straight line the gradient of which depends on the velocity, as would be expected, but it does not pass through the origin The latter discrepancy has been explained by Ruchart as due to residual gases emitted from the metal parts of the tube and from the cement, and can be reduced by reducing the size of these elements. As the velocity of the particles is increased by increasing the accelerating potential, L_2 becomes smaller while L_1 becomes larger, the ratio L_1/L_2 ranging from about 0·05 to 0·5 From the mean free path the collisional radius of an atom can be calculated, and this is found to lie between the first and second Bohr orbits in the case of hydrogen The free paths are given by Ruchart's method with an accuracy of a few per cent

A further investigation has been made on the subject of the mean free paths by the study of the light emitted. Three kinds of mean free path have to be considered in this connexion. (1) The first is the path for the " duration of luminosity " , this path begins when the atom is excited by the raising of an electron to a higher energy level within the atom, and ends when the electron returns with emission of light. Eighteen years ago Prof Wien compared the luminosity of a black body at a temperature of about 1100° C. with that of the canal rays, in a vacuum so high (0 001 mm for hydrogen) that the effect of collisions could be neglected The energy emitted by the canal rays as light was thus determined in absolute measure, and from this it was possible to calculate the light energy emitted per atom per cm of an atom's path. The observations were made in a vacuum chamber separated by a very fine slit (through which the canal rays passed) from the tube in which the rays were produced, and were concerned with the strongest lines of hydrogen, oxygen, nitrogen, helium and mercury It was found that the luminosity fell off exponentially with distance along the path of the rays, and from the exponential constant the mean free path for duration of luminosity can be calculated by introducing quantum considerations It amounts to a few centimetres The measurements just mentioned related to the state of things in a very high vacuum, the slit referred to being so fine that the vacuum in the experimental chamber could be kept at much lower pressure than that in the discharge tube

At higher pressures, however, the effect of collisions comes into play, and it becomes necessary to consider two further kinds of mean free path, namely, (2) the path which begins when an atom becomes normal and ends when it is excited, on collision, by the raising of an electron to a higher energy level ; and (3) the path which begins when the atom is excited, as described, and ends not with the emission of light but with ionisation by a further impact Prof Wien termed the latter process " perturbation "

This question has recently been investigated by Prof. Wien by the use of a discharge tube separated from the experimental chamber by a slit so fine that a great difference of pressure could be maintained between its two sides by the use of a diffusion pump ; with a vacuum in the tube of 0·02 mm., the pressure in the experimental chamber could be raised to 8 mm. or more. The intensity of the line H_α (displaced by the Doppler effect) was then compared at various pressures, and it was found that for high vacua the intensity was proportional to the pressure, but for pressures above about 0 5 mm the intensity was constant. At low pressures few perturbations take place, and as the excitations are proportional to the number of collisions, the intensity is proportional to the pressure. At high pressures, however, the mean free path for collision is small compared with that for the " duration of luminosity " ; the excited atoms are more frequently prevented by " perturbing " collisions from emitting light, and ultimately the perturbations balance the excitations and the intensity becomes constant.

The apparatus used for measuring the " duration of luminosity " has also been adapted for use in a method

[1] Substance of the tenth Guthrie Lecture delivered before the Physical Society of London on April 25, by Prof W Wien.

for discriminating between the spectral lines from charged and those from uncharged particles. A small condenser is placed close to the slit so that the canal rays pass between its plates, the vacuum being as high as possible so that the particles may not, after passing through the slit, become charged or uncharged through collisions The spectrum of the light emitted by the rays is then photographed, first with the condenser short-circuited and then with the condenser charged. (Apparently the slit ordinarily employed in a spectroscope is here dispensed with, the line corresponding to each wave-length being an image of the pencil of rays itself) Since the charged particles are deflected by the electric field, the lines due to these particles are distorted when the condenser is charged and can thus be distinguished from the lines due to uncharged particles Photographs were shown in which certain oxygen and hydrogen lines were seen to be undistorted by the influence of the condenser, while others were clearly distorted The latter belong to the spark spectrum of oxygen, while the former are arc lines A similar distortion was observable with the band spectrum of nitrogen.

The foregoing considerations throw light on an apparent discrepancy between measurements of the velocity of the rays by electromagnetic methods and by the Doppler effect respectively The velocities as measured electromagnetically increase in proportion to the square root of the accelerating potential, in accordance with theory, but the velocities as measured by the Doppler effect have been found by several observers to reach a limiting value as the accelerating potential rises beyond a certain stage Dr. Krefft, however, raised the accelerating potential in a tube filled with hydrogen to 70,000 volts, and in this case he found no limiting value for the Doppler displacement; the latter indicated a velocity increasing in proportion to the square root of the potential, but its absolute value was less than what would be expected from the velocities measured electromagnetically. The arc lines of oxygen also show an unexpectedly small shift, while the spark lines show a larger shift. The discrepancy referred to may therefore be attributed to the fact that the bulk of the luminosity comes from uncharged atoms while the electromagnetic measurements relate to charged particles, which on the average have greater velocities

A further investigation has been made by Ran, who arranged a glass cylinder close to the canal rays and with its axis perpendicular thereto In this way light from both approaching and receding particles is collected by the cylinder and focussed on the slit of a spectroscope. Ran found some evidence for regarding the band spectrum of nitrogen as emanating from positively charged particles

New results have been obtained by Dopel in the analysis of positive rays by Sir J J Thomson's method, negatively charged particles of H, H_2, He, and Ne (or ? O) having been found. Most positive-ray parabolas show two regions of maximum intensity, and a new explanation is suggested for this phenomenon, namely, that the second maximum is due to particles of double mass originating in the discharge chamber but afterwards dissociated The existence of molecules of He_2 and H_4 would be implied by this theory, but not H_6, since there is no second maximum in the case of H_3

Prof Wien remarked in conclusion that the work on positive rays affords an excellent example of the results of international co-operation in science, which he regards as of the utmost value and importance. C W H

International Commission for the Investigation of the Upper Air.

A MEETING of the International Commission for the Investigation of the Upper Air was held in London on April 17-22

At the meeting of the Commission in Bergen in July 1921, the Commission adopted the view that the international publication of the results of the investigation of the upper air ought to be resumed, and that an International Bureau should be established and supported by contributions from the different States, so that the preparation and compilation of the results should not in future be done at the sole cost of the National Service which undertook the work. Unfortunately, it did not prove practicable, in the stringent economic times which followed the meeting of 1921, to obtain the funds which were necessary to carry out the recommendations of the meeting at Bergen. In consequence of this, Prof. V. Bjerknes, who had been president of the Commission, resigned his position, as he could not spare the time from his purely scientific work to carry out unaided the large amount of work involved in the preparation and publication of the international upper air results. Sir Napier Shaw, then President of the International Meteorological Committee, took over the presidency of the Commission at the request of the members.

Various methods for securing the object of an international publication of upper air results have been considered or tried experimentally since that time. No satisfactory solution of the question has been achieved. A short meeting of the Commission was held after the International Conference at Utrecht in 1923 at which the results of the inquiries were briefly surveyed, and a preliminary discussion took place on the most appropriate form for an international publication.

In 1924, at the meeting of the International Union for Geodesy and Geophysics at Madrid, the Union voted the sum of 500*l* towards the expenses of publication of a specimen volume of upper air data, and Prof. van Everdingen, the director of the Meteorological Institute of Holland, promised a contribution of about 100*l* for the same purpose

The meeting of the Commission in London was concerned primarily with the consideration of the form which the specimen publication should take. Representatives from the following countries attended. France (Capt. Wehrlé), Germany (Prof Hergesell), Great Britain (Sir Napier Shaw, Sir Gilbert Walker, Capt C. J. P Cave, Lieut.-Col E Gold, Mr L H G. Dines, Mr L F Richardson), Holland (Prof van Everdingen, Prof van Bemmelen), Italy (Lt.-Col. Matteuzzi, Prof Gamba), Norway (Dr Hesselberg); Russia (Dr Molchanoff), Spain (Col. Meseguer). The meetings of the Commission were divided into business meetings and scientific meetings, on the ground that a right solution of the questions which the Commission had to consider could only be achieved by a correct appreciation of the scientific principles involved. There were four business meetings and three scientific meetings.

At the first meeting of the Commission on Friday, April 17, the president read a letter from Mr la Cour, director of the Danish Meteorological Service, giving the Commission the welcome news that four wireless stations would be in operation in Greenland during the coming summer, at Angmagsalik, Julianehaab, Godthaab, and Godhavn, and that all four stations would be equipped with instruments for observations of pilot balloons. The work of the four stations as regards investigation of upper wind would be co-ordinated by wireless with the view of obtaining simultaneous ascents to great heights from all stations at the same time.

In a communication from M. Fontséré (Barcelona) an account was given of some observations on oscillations of short period, indicated by the well-known oscillations of the motion of pilot balloons, as seen in a pilot balloon theodolite. These oscillations appear to have a period of about three seconds, and do not appear to be due to natural oscillations of the balloon The Commission decided to recommend that a similar investigation should be undertaken in other places, and that the influence of the size and form of the balloon on the character of the oscillations should be explored, and that a comparison of the oscillations observed in balloons with those observed in the tension of kite wires should also be made

After some discussion of the use that should be made of the funds placed at the disposal of the president, the Commission decided that they should be applied to the publication of a specimen volume of upper air results for 1923 and 1924, and that in the specimen volume the observations obtained from *ballon-sonde* and similar records from the places selected for international investigation, should be published in the form of tables giving full details, and that the tables should be supplemented by graphical representation on " tēphigrams " This is the name given to the representation of the results of the *ballon-sonde* ascents, by plotting corresponding values of temperature t, and entropy ϕ, which is proportional to the logarithm of potential temperature T This form of representation, which was invented by the president and explained by him at the scientific meeting, is peculiarly appropriate for presenting the results of temperature (and humidity) observations in the upper air It shows immediately the relation of the temperature gradient observed in the ascent to the adiabatic gradient for dry air and the adiabatic gradient for saturated air It shows the energy which would be required to raise air vertically in the atmosphere under the conditions of the ascent, or alternatively, the energy that would be set free in a kilogram of air rising in the atmosphere under the conditions of the ascent It also has the great advantage of presenting these results in a diagram of very moderate dimensions, even when observations at heights of 50,000 feet or more are included.

Considerable discussion took place on a proposal sent by Dr Marvin for concentrating all the international *ballon-sonde* ascents in any one year into a single month. The proposal to obtain ascents daily for a month in addition to ascents on single days in other months of the year, was advocated by Lieut.-Col. Gold at the meeting at Bergen in 1921, but it was rejected by the Commission on the ground that the funds available for upper air investigation should be devoted to obtaining results for detailed investigation on the lines adopted by the Norwegian Geophysical Institute. After much discussion of Dr. Marvin's proposal, it was agreed that countries participating in the international investigation of the upper air should be asked to make, so far as possible, daily ascents distributed throughout a month in each year, the month to be selected by the International Commission, these ascents to be additional to those indicated in the scheme of international days prepared by the Commission at Bergen for the years up to 1928. The first month selected for this more extended investigation is May 1926, and the next month is October 1927. (It was considered that the time was too short to warrant an " International Month " in 1925, but it was agreed that any auxiliary *ballon-sonde* results which any country might be able to make, should be made in August.)

In the course of discussion of this resolution, Prof. Hergesell emphasised that the international investigation of the upper air has two aspects, the world aspect and the regional aspect. From the world aspect, ascents over a month would be appropriate, and from the regional aspect, ascents concentrated into shorter periods of time, and made more frequently, would lead to better results. Dr. Simpson, following up this line of thought, made the suggestion that the Commission itself should deal only with the world aspect and should appoint regional sub-commissions to deal with regional aspects. The Commission eventually decided that the regional aspect could, in the meantime, be dealt with satisfactorily by the nomination of deputy-presidents in the following different regions Europe, with Russia, Siberia, and North Africa; North America, the East Indies and the Philippines, Australia, South Africa, South America It was agreed that the six ascents left at the disposal of the president should be concentrated in the international months, and the exact dates in the different regions should be left to the deputy-presidents for these regions Dr. Marvin was designated as deputy-president for North America and Mr. J H. Field for the East Indies.

The question of adopting an international formula for the rate of ascent of balloons, put forward by Dr. Weinberg (Leningrad), led to the appointment of a sub-commission to consider this and other questions relating to balloons, and to report to the next meeting of the Commission The members of the sub-commission are. Prof Hergesell (president), Dr. Hesselberg, Mr. J. S. Dines, Dr. Molchanoff, Col. Matteuzzi, Dr Marvin, and Mr Fujiwhara

The importance of aeroplane observations, and the difficulty of securing satisfactory instruments for them, was emphasised by Capt Wehrlé, and the Commission decided to ask for complete particulars of the instruments and methods used in different countries to be communicated, with the view of their publication in collected form by the French Meteorological Service.

As regards the future, it was decided that the question of a regular international publication could only be settled satisfactorily after the specimen volume had been issued and considered. The question of the publication of results after 1924 was, therefore, remitted to the next meeting of the Commission, which it is anticipated will be held at Prague in 1927.

On Thursday evening, April 16, the delegates were entertained by the president at an informal " At home " at his house. Various graphical methods of presentation and illustration of upper air results were exhibited, and some interesting photographs were shown illustrating the growth and decay of vortices in a fluid in connexion with the theory which Mr. Fujiwhara has developed of the vortex motion exhibited in clouds. On Friday, April 17, the delegates were entertained to dinner by the Meteorological Office. On Sunday, April 19, they were invited by Capt. C J. P Cave to lunch at the Beacon Hotel at Hindhead, and afterwards to tea at Stoner Hill, Petersfield, where they had an opportunity of seeing an unrivalled collection of cloud photographs, while the rain outside witnessed to the accuracy of the Meteorological Office forecasts. On Tuesday afternoon, April 21, they paid a visit to Kew Observatory in connexion with the seventy-fifth anniversary of the Royal Meteorological Society, and on Wednesday evening they were entertained at the anniversary dinner of the Society.

The outstanding impression left by the meeting may be illustrated by a remark to me of one of the foreign delegates: " What I like about this international work is the way everybody is ready to help things forward; the only consideration being, 'Is the thing good?' It is very pleasant." E. GOLD.

Historic Scientific Instruments in the Old Ashmolean Museum, Oxford.

ON Tuesday, May 5, the Old Ashmolean Museum at Oxford was reopened as a home for old scientific instruments, especially the magnificent collection presented to the University by Mr Lewis Evans, on whom the honorary degree of D Litt. was first fittingly conferred After this, a large and brilliant gathering assembled in the Divinity School under the chairmanship of the Vice-Chancellor to hear an account of the collection from Mr. R W. T. Gunther, fellow of Magdalen, who has been appointed curator; and an address from the Earl of Crawford and Balcarres, president of the Society of Antiquaries, who performed the opening ceremony

The Old Ashmolean Building, which embodies many of the features of Wren's design for a College of Science, was originally opened on May 21, 1683, by the Duke of York, afterwards James II., and it was pleasant to have at this second opening, nearly 250 years later, a cordial message from the present Duke of York, transmitted through a specially appointed representative, the president of Magdalen Lord Crawford, in some inspiring words, welcomed the dispelling of the mischievous fallacy that there is a necessary antagonism between science and art, for in the present exhibition the two are practically combined. Instruments that have become scientifically obsolete survive as beautiful works of art

The company had ample opportunity to verify this statement, for many of the exhibits have indeed great beauty of workmanship A little crucifix, the arms and sides of which constitute a vertical sundial, while the interior is filled with drawing instruments, came in for special admiration. Its instruments were spread out beside it, and their number almost suggested that it might be difficult to get back the "genie into the bottle" Dr. Evans has told us that his collection began (when he was only eleven!) with sundials; and though it expanded later to include astrolabes and other instruments of precision, it took him twenty years to find his first astrolabe. He was really trying all that time to get one, and prepared to spend money on it, but there were none to be had In view of the number he has now accumulated, this is very surprising. An interesting development of his collecting tastes is represented by a very fine set of gunnery levels, specially admired by another collector of these treasures.

Besides the Lewis Evans collection itself, there are many other loans and gifts, attracted partly by the new and splendid opportunities for presentation, and partly no doubt by Mr Gunther's persuasiveness Miss Willmott has lent a remarkable astronomical clock, with an astrolabe as dial, two hands to show the positions of the sun and moon, and a mean time clock at the back—all beautifully ornamented Christ Church and Oriel have both lent important collections—the former a collection of orreries. Doubtless other gifts and loans will come Mr. Gunther was specially gratified to receive a note from Mr E B Knobel after his visit "I see from your catalogue you want a Davis's Backstaff I'll send you one" There are copies of two Galilean telescopes and a Hooke microscope which come from special funds Perhaps the best example of the advantages brought by the new opportunities is the conjunction of (*a*) the first circular slide rule (1632), invented by Oughtred, (*b*) portraits of Oughtred and of Elias Allen, the maker, (*c*) two books on the subject by Oughtred and Allen Now (*a*) is a loan from St John's College, (*b*) from the Hope collection of portraits in Oxford, while (*c*) are from the Evans collection Thus we see the value of Oxford as a collecting and combining medium, but again, we must not undervalue the knowledge which Mr Gunther had gradually acquired of the (formerly) hidden resources of Oxford.

We may regard Tuesday's ceremony as the very satisfactory ending of a period of doubt and difficulty with regard to the Lewis Evans collection The joys of collecting are great, but there comes a time when some anxiety as to the ultimate fate of the collection must temper those joys. Such anxieties must now have been dissipated; and for this happy result we have in great measure to thank the Vice-Chancellor, without whose sympathy and liberal views of the functions of a University even Mr Gunther's energy might have failed to clear the path from difficulties

Two points of detail may be mentioned The little catalogue of the instruments is on sale in the *Old* Ashmolean Building, *not* in the Ashmolean Museum as (erroneously) printed on the cover The danger of this confusion is well-nigh unavoidable Secondly, those interested will find some really excellent pictures of building and exhibits in *Country Life* for May 9.

H. H. T.

Growth Stages of a Crustacean.

EVERY student of zoology has some acquaintance with the larval stages of those Crustacea that undergo metamorphosis, but there has hitherto been no detailed account of the changes during growth in any of the species in which development is direct. In the course of researches on the genetics of *Gammarus chevreuxi* carried out at Plymouth, Mrs. E. W. Sexton found it necessary to have fuller information as to the characters of the successive stages from hatching to maturity. She therefore set herself to the laborious task of studying and depicting, with her well-known artistic skill, complete series of the moulted skins of isolated individuals. The results are now recorded in a paper (Journ. Marine Biol. Ass., vol. 13, No. 2, pp. 340-396, 21 pls., 1924) which is of unusual interest and importance from several points of view.

Apart from certain changes in the proportions of the body, the differences between the various stages are slight and concern mainly the form, number and position of the hairs and spines on the body and limbs. These trivial differences, however, are remarkably constant, and by means of them the successive stages can be as sharply defined and as surely recognised as can the larval stages of those Crustacea in which the changes of form are more striking It is especially noteworthy that this constancy is undisturbed even by considerable changes in the environment *Gammarus chevreuxi* will live and breed equally well in fresh, brackish or sea-water, it breeds all the year round, and the winter broods take more than twice as long to reach maturity as do those hatched in the summer, yet "the stages of growth were found to be identical, even to the number and position of the hairs." As these statements are based on the study of more than 3000 moults obtained during a period of twelve years, we may confidently take Mrs Sexton's word for it

Sexual maturity is reached by both sexes after the seventh moult. The females continue to grow and to moult without further change of form. The males, however, do not attain their definitive characters until the ninth moult. There are, therefore, three

forms of breeding male which might well be taken to belong to different species. It is suggested that this fact, hitherto unknown, may have caused much confusion in the taxonomy of these Amphipoda

The occurrence of "intersexes" in this species has already been recorded in earlier papers by Mrs. Sexton These were "female intersexes," and the study of their life-history now shows that they begin as females and develop more and more of the male characters as they grow "Male intersexes" are also mentioned, but these might be better described, perhaps, as incomplete males, since their effeminate appearance is due rather to the persistence of immature characters than to the assumption of those that are peculiarly female.

Brief accounts are given of the life-history of three other species of Gammarus found at Plymouth Although the structural characters which distinguish them might be thought trivial by any one but a specialist, the differences in their breeding habits are very marked and "probably form an insuperable bar to cross-breeding" even when the species occur together

A small detail of interest to the morphologist was observed in the antennules On the upper surface of the first segment is a narrow longitudinal groove planted with a row of plumose sensory hairs This is, no doubt, a vestige of the so-called "auditory sac" or statocyst, found in many decapods and also in the Syncarida but not hitherto recognised in any other Crustacea

In passing, Mrs Sexton deals with "a picturesque legend" which has been widely quoted from Spence Bate, who gives it on the authority of Dr. James Salter. It is to the effect that the young gammarids, on quitting the brood-pouch of the mother, keep close to her as she swims about and, on the approach of danger, rush back to the pouch for shelter Spence Bate not only expends some rhetoric on this "interesting instance of maternal solicitude," but also gives us a pretty picture of the mother Gammarus accompanied by her brood Mrs Sexton tells us that there is not a word of truth in the whole story The young could not possibly re-enter the pouch if they tried, and in *G. locusta*, the species to which Spence Bate refers, hatching is followed immediately by emergence of the young, moulting of the mother and deposition of a fresh batch of eggs W. T. C

University and Educational Intelligence.

CAMBRIDGE.—The Museum of Archæology and Ethnology has received from the Earl of Denbigh the Pennant Collection consisting of a very important series of ethnological objects collected by Captain Cook himself in the Pacific, a series of archæological specimens which is of great interest and value.

Dr Scott, Trinity College, has been reappointed curator in entomology, Mr P M S Blackett, King's College, has been appointed assistant demonstrator of experimental physics, J Barker, Trinity College, has been reappointed to the Frank Smart studentship in botany; A B Deacon, Trinity College, has been elected to the Anthony Wilkin studentship in ethnology and archæology; G E. Hutchinson, Emmanuel College, has been nominated to use the University table at the Zoological station at Naples

Prof Niels Bohr is lecturing on "Problems of the Quantum Theory" at the Cavendish laboratory, on Friday, May 15

The annual report of the Board of Research Studies provides interesting reading The number continues to rise and there are now 248 students registered and working under the administration of the Board. The chief increase in any subject is in physics, where there are now 40 research students. The number of Cambridge graduates who have registered as research students continues to increase and has now reached 80. The number of American students shows a marked increase The distribution in colleges still remains very unequal, the numbers ranging from 46 at Trinity College, 38 at Emmanuel College, and 34 at Gonville and Caius College to 2 at Pembroke College, 1 at Jesus College, and 0 at Selwyn College.

LONDON.—A free public lecture (in English) on "Modern Conceptions of Light Stimuli in Plants" will be given by Prof F. A. F. C Went, of the University of Utrecht, at the Imperial College, Royal School of Mines, on Monday, May 25, at 5 15. No tickets will be required

The University Studentship in Physiology, value 50*l*., will be awarded to a student qualified to undertake research in physiology. Applications should reach the Academic Registrar by, at latest, June 1.

Applications are invited for grants from the Thomas Smythe Hughes Medical Research Fund for assisting medical research They should be sent, accompanied by the names and addresses of two references, to the Academic Registrar, University of London, South Kensington, S W 7, not later than June 15

MANCHESTER.—In connexion with the Municipal College of Technology the Edmund Mills Harwood Memorial Scholarship, value 50*l* a year, and tenable for three years in one of the University engineering courses, is offered for competition Forms of nomination and further information are obtainable until June 15 from the Registrar of the College

PROF B HELFERICH, of Frankfort-on-Main, has been invited to occupy the chair of chemistry at Greifswald in succession to Prof R Pummerer, who has been transferred to Erlangen.

THE Society for the Advancement of the Training of Mechanics, Leyden, has arranged for the holding in August of vacation courses for mechanics and glass-blowers in the workshops of the Physical (Cryogenic) Laboratory of the University of Leyden. Information respecting the courses can be had from the Secretary, Dr. C A Crommelin, at the laboratory.

THE University of Birmingham has evolved a system of research economy which deserves to be commended to the notice of other institutions Four years ago, the University established a Joint Standing Committee for Research with the object of making a general policy and recording from session to session as completely as possible all the research work conducted by members of the University staff The committee's main work is now to grant financial assistance from its own resources, to support, at its discretion, applications by heads of departments to outside bodies, to keep in close touch with all work properly described as research work going on in University Departments or in Departments working under the University, and to record and publish work completed and in progress. With the third annual report (1923–24) particulars were published of 170 researches in progress in the faculties of science, art, medicine, and commerce, and of 150 publications embodying completed researches, and, in addition, accounts of archæological excavations and of work carried out under the City and University Joint Board of Research for Mental Disease. The resources of universities are so diverse that a common policy in regard to the promotion and organisation of research may not be called for, but in regard to systems of recording and classifying particulars of research, the advantages of uniformity are very

evident, and ought to be attainable without much difficulty.

IN his presidential address on "University Ideals" to the Yorkshire Natural Science Association in Bradford, which has recently been issued, Prof A. F. Barker of Leeds discusses the ideals characteristic of the schools of the humanities, of pure science, and of applied science, and the relation to them of the scientific and technological bias, which is the most distinguishing feature of the modern universities. He adopts the view of Dr L. P Jacks, that so long as civilisation remains predominantly industrial, all attempts to find culture, religion, salvation outside the sphere of our daily work must "resolve themselves ultimately into spoken nothings." To render the training of the faculties fruitful, they must be made sensitive to the appeal of natural science. The student must be taught to regard Nature, natural science, technology, and the objective world generally as a mirror in which man may see himself "The limitation of our powers of vision is in ourselves; and the University's highest and deepest concern lies in the stimulation, through contact with the subjective and objective worlds and with the everyday life of the world which lies about us, of the light within ourselves—of our evolving consciousness" This is to apply in the university the principles of what is known in American pedagogical terminology as the "project method" The same principles are advocated in a pamphlet by Prof J W. Scott of University College, Cardiff, under the name of "the regional idea," for revitalising the teaching in our elementary schools to the end that their pupils may be better equipped for life in the world of industry ("Unemployment—a suggested remedy," A. and C Black, 1925, 1s. net) In connexion with the encouragement of individuality in organisation, which seems to Prof. Barker an essential feature of the modern university system, he refers to "the fight for the inclusion of the Research Associations within the university," and "the fight which is now being waged in several of the modern universities in England for the reintroduction of religion into the university life in some form or other."

THE morning session of the annual Conference of the Universities of Great Britain and Ireland, held at King's College, London, on May 9, was devoted to a discussion on "The Function of the Universities in Relation to Agriculture" Sir Daniel Hall, chief scientific adviser to the Ministry of Agriculture, was the principal speaker He is of opinion that agriculture students and courses fall into three groups: at certain universities, notably Oxford and Cambridge, many of the future landowners of the country form a considerable proportion of the students For them a degree course in agriculture is required which will awaken in them a sense of their responsibilities and opportunities. Then there are the men who actually intend to farm; they require a technical training, which might be more conveniently given at a university than at a separate agricultural college, where they would miss that opportunity of widening their knowledge which contact with students of different subjects in a university affords. Finally there are teachers, scientific workers and officials, whose training should be based on a degree course in arts or in pure science Sir Daniel thinks that there are sufficient agricultural colleges already in Britain and that each should pick out its special group and cater for its needs. In the discussion which followed, Mr. M. J. R. Dunstan, principal of the Royal Agricultural College, Cirencester, suggested a round-table conference of university authorities in Great Britain to decide the scope and training for an agricultural degree.

Early Science at Oxford.

May 18, 1686. Some of this Society having considered that place of Tacquet's Geometry, mentioned in the Minutes of the Dublin Society of March ye 8th observed that there is this difference betwixt Mr Caswell's first Problem and Tacquet's, viz that in each of Tacquet's Triangles there is one side and 2 Angles given, which is an ordinary case of Trigonometry But none of Mr Caswell's Triangles has one side and 2 angles, or 2 sides and one angle, or 3 sides given; and this makes a greater difference in the Solutions than that mentioned, in those minutes

Then was read an account of the Torricellian experiment, tried on the Mountaines of Snowdon, Cader Idris, &c with the heights of those mountains taken by Mr. Caswell

An account was given of *four children* born at a birth, at Marston near Oxford, the last Mounth

May 19, 1685 A Letter from Dr Mark, Physitian to the Elector of Brandenburg, and Member of this Society, dated Potsdam, March 28, 1685, was read, It brought an account how well his Electorall Highnesse is pleased with ye design of this Society His Highnesse having commanded Dr. Mark to continue a strict correspondence with us, and promising him assistance, by furnishing him with matter to communicate, when his own stock shall be defective The Elector also commanded him to enquire concerning ye Concha, which affords ye Purple, and of ye way of making Amianthus-paper, and to procure both, if possible He has also given orders for some of ye Philosophical Transactions to be sent over The Society ordered their humble thanks to be returned to Dr Mark for this welcome newes, for the Honour done them in it; and for (the occasion of it) ye character he has been pleased to give of this Society to the Elector, and that answers be speedily sent to ye queries in ye Letter, and that ye Letter itself be carefully preserved among ye papers of this Society.

Proceeding then to other matters, two specimens of bookes, now in the presse, were shewn us, one a History of Fishes, written, some years since, by Mr Willoughby, and Mr. Ray: the other, a History of Plants, by Mr Ray, after his new method

A Sort of Earth, dug at Hogsdon, 8 or 10 foot deep, of an Aromaticall smell, was communicated by Dr Plot; who inform'd us, that the Water under this Earth is found Bituminous, from whence, he conjectures, ye Earth may be supposed to have this flavour.

May 20, 1687. Mr President was pleasd to communicate a letter from Mr Halley, which gives an account of Mr Newton's Book *de Systemate Mundi* now in ye presse, giving an account of ye reasons of ye Celestial motions &c; and of Mr Hooks finding ye meridian line with great exactnesse by the help of a Small constellation near ye Pole—Mr. President also communicated a Letter written by him in answear to Mr Hally's, giving an account of ye reasons, why he can not be of Mr. Hooke his opinion, concerning the figure of ye earth

May 22, 1688. Mr Molyneux sent an account of the Inhabitants of the Barony of Forth in the County of Wexford, who are the Progeny of the first English Planters that came over with Fitzstephen and conquered Ireland in Henry 2ds Time. Till the times of their late confusions in Ireland (he says) they retain'd in great Measure their Antient Language, neither good English nor Irish, but easyer understood by a perfect Englis man then Irish That till of late they allways kept their Marriages intire amongst themselves.

Societies and Academies.

LONDON

Royal Society, May 7.—W. **Rosenhain** and Miss J. **McMinn**. The plastic deformation of iron and the formation of Neumann lines. Experiments have been made to ascertain the effect of variations of speed on the mode of deformation of nearly pure iron. Small rectangular prisms, having one face prepared for microscopic examination, have been compressed slowly in a testing machine and also under the blow of a falling weight. Within the range of speeds possible on the testing machine used (from 20 minutes to approximately 1 second) slip bands of very similar character are formed. When, however, such a specimen has been compressed by the blow of a falling weight very few slip bands are formed, but the crystals are crossed by much heavier and usually very straight black bands, which have been identified with the well-known Neumann lines. The formation of Neumann lines is probably not due to twinning; they are rather of the nature of broad slip regions, possibly formed by the close juxtaposition of a large number of slip planes. The surfaces on which slip has recently occurred are regions of weakness for further deformation by shock, although they do not appear to behave in the same way with further gradual deformation.—A. E. H. **Tutton**. (1) The monoclinic double sulphates containing thallium.—Thallium nickel and thallium cobalt sulphates. The two salts are $Tl_2Ni(SO_4)_2\ 6H_2O$ and $Tl_2Co(SO_4)_2\ 6H_2O$. They show close isomorphism with salts of the series containing the alkali metals, but not "eutropism" (progression with atomic number). Thallium in its thallous capacity is thus capable of replacing the alkali metals in the crystals of these double salts, with only a relatively small amount of change like that produced by alkali metal interchange, but without relationship to atomic number. The two new thallium salts, in common with those previously studied and also with the simple rhombic sulphate and selenate of thallium, are distinguished by their very high (relatively to other salts of the two series) refraction and dispersion. This is probably where the more complicated nature of thallium atoms produces its effect. (2) The crystallographic and optical properties of iodo-succinimide. Miss Yardley's X-ray results indicated a structure corresponding with the symmetry of Class 9, the pyramidal polar class of the tetragonal system, one of the classes in which optical activity in two optical antipodes is possible. It has hitherto been assumed that iodo-succinimide is ditetragonal pyramidal (Class 13). New morphological constants were found and optical activity has been discovered, blocks about 4 mm. thick being required to exhibit it clearly. Hence, Miss Yardley's conclusion that the symmetry is that of Class 9 is in every way confirmed.—Kathleen **Yardley**. An X-ray examination of iodo-succinimide. The dimensions of the true unit cell are $6{\cdot}29 \times 6{\cdot}29 \times 15{\cdot}55$ Å.U. This minimum cell contains four molecules. The X-ray measurements predict that the crystals should be optically active; Dr. Tutton has since shown that this is actually the case.—B. **Lambert** and S. F. **Gates**: An investigation of the relationships existing between hydrogen and palladium. The "ascending" pressure-concentration isothermal drawn through equilibrium points obtained after successive additions of hydrogen to palladium is not, in any sense, an equilibrium curve. The "descending" pressure-concentration isothermals, drawn through equilibrium points obtained after successive withdrawals of hydrogen from the system, are regular, but interruption of the smooth withdrawals of gas by occasional additions of gas, and temporary cooling, have marked effects; the "descending" isothermal cannot, then, be considered an equilibrium curve. The existence, under some conditions, of a simple compound, Pd_2H, is considered not improbable.—C. G. T. **Morison**: The effect of light on the settling of suspensions. Fine-grade suspensions of soil and kaolin were used in the absence and presence of light. When a suspension settles in the absence of light the settling is uniform and normal. In the presence of light it develops well-marked striations and discontinuities.—Colonel N. T. **Belaiew**: On the inner crystalline structure of ferrite and cementite in pearlite. Pearlite, the "pearly compound" of Sorby, is built up of grains of alternating lamellæ of cementite and ferrite. The orientation of these lamellæ is different in different grains. The cementite lamella shows its "petal-like" structure and seems warped and twisted. The exposed outer edge shows rectangular steps pointing to a constant linear unit. The ferrite lamella reveals, at the edge, "isolated cubes" of ferrite of about 250 $\mu\mu$ edge. The ferrite lamella seems to be built up of a multitude of such small cubes, and both the warping of the cementite lamellæ and the cracking of ferrite may be traced to the Ar_1 point, where the expansion of volume, due to the change from the face-centred to the cube-centred lattice in iron, counteracts—in the pearlite areas—the normal contraction of the cooling specimen. Reacting to the ensuing stresses, the cementite lamella becomes warped and twisted, and the ferrite splits up into a multitude of blocks or cubes.

Royal Microscopical Society, March 18.—C. **Da Fano**: (1) On the mounting in series of specimens stained by the Weigert-Pal method. Well-bichromated material is embedded in celloidin. The blocks are cut serially and the sections placed in order on slips of smooth paper. After drying with filter paper a progressive number is written with a mixture of 10 c.c. of indian ink and 3 c.c. of equal parts of ether and acetone on a corner of the celloidin by means of a brush. The sections are floated in weak alcohol, washed, and mordanted in a mixture of potassium bichromate 5 gm., chromium fluoride 2·5 gm., distilled water 100 c.c. They are then stained in Kultschitzky's hæmatoxylin, differentiated by Pal's method, counterstained and mounted according to the progression of their numbers. (2) Golgi-Cox preparations mounted permanently in series. Relatively large pieces of nerve tissue or even entire brains from small animals are placed in Cox's mixture. The fluid should be changed after 24 hours and again on the third day. The pots containing the material are sealed and kept for a month at 24° C. and then for about 6 months at room temperature. The pieces are washed, dehydrated, embedded in celloidin, and serial sections made.—A. S. **Parkes**: The age of attainment of sexual maturity in the albino mouse. The examination of the gonads of young mice showed that mature spermatozoa are produced by the male at a much earlier age than ova are produced by the female. In the case of the male, active spermatozoa first appear in the epididymis during the sixth week of life. Testis sections corroborated this finding. In the case of the female the first ovulation occurs about the eighth week, though the condition of the animal obviously has a considerable influence in determining the time of the first production of both ova and spermatozoa. The vaginal orifice first opens towards the end of the seventh week, at which time also the uterus develops to a condition approaching maturity.

Royal Meteorological Society, March 18.—C. K M. **Douglas**: The relation between the source of the air and the upper air temperature up to the base of the stratosphere. Trajectories of "gradient" wind were drawn, showing the previous history of the air in which *ballon sonde* ascents were made, in cases where the place of fall of the balloon showed no great change of wind with height These showed that the latitude of the air three days previously is highly correlated with the temperature at all heights to the base of the stratosphere, with the height of the stratosphere, and with the pressure at 9 km The latitude effect, which in general represents the temperature difference between "polar" and "equatorial" air, increases somewhat with height, up to at least 6 kilometres — A H R **Goldie**. Waves at an approximately horizontal surface of discontinuity in the atmosphere Autographic instruments with open time scales show examples of fluctuations of atmospheric pressure which are undoubtedly periodic By way of determining the origin of these, the general problem of wave-motion at the common boundary between two air currents differing in density and in velocity and direction of motion is discussed. The theory can account plausibly for the observed facts; waves with amplitudes in the bounding surface of from 150 to 750 metres or perhaps more, and with lengths of the order of from 5 to 20 kilometres, must be of comparatively frequent occurrence.—Sir **Napier Shaw** and H **Fahmy**. The energy of saturated air in a natural environment

DUBLIN

Royal Dublin Society, March 31.—H. **Pringle** The identity of vitamin A the comparative effects of human and cow's milk. Cow's milk is much more efficacious than human milk in promoting growth in rats —J **Wilson**: The variations in the quantities of food required by cattle for maintenance and fat production with various kinds of rations From Kellner's own experiments, the quantity of food required by cattle for idle maintenance is not constant, as Kellner found, but varies with the kind and quantity of long fodder in the ration. With 11 to 12 cwt bullocks, it is equivalent to about 13, 15, and 16·5 lb of hay, when the ration contains less than 0·6 lb of hay, about 1 lb. of hay, and about 1 lb of hay and straw respectively per live hundredweight of the animal. When the bullock is fattening, the quantity of food required to put on fat varies with the kind and quantity of long fodder in the ration and with the rate of fat production If all not retained by the animal be regarded as maintenance, the bullock, like the pig, puts on a pound of fat with a little more than 2 lb of meals.

PARIS.

Academy of Sciences, April 6.—The president announced the death of M. Rabut, member of the Academy.—H. **Vincent**: New researches on the pathogeny of colibaciluria .The action of an anti-colibacillus therapeutic serum. — L. **Vegard**, H. **Kamerlingh Onnes**, and W. H. **Keesom**: The emission of light by solidified gases at the temperature of liquid helium, and the origin of the auroral spectrum.— P. J. **Myrberg**: Arithmetical invariants.—H. **Eyraud**: Two complementary deformations of space.—Léon **Pomey**: The integration of differential equations with general initial conditions comprising those of Couchy.—Mlle. O. **Jasse**: Observations of the Schain (1925 *a*) and Reid (1925 *b*) comets made at the Marseilles Observatory (Eichens equatorial, 26 cm. aperture). Positions given on March 29 and 30. Schain's comet forms a nebulosity 2′ in extent, with a nucleus of 11·5 magnitude. Reid's comet, 9·5 magnitude, shows a strong condensation surrounded by a nebulosity 3′ in extent.—P. **Chofardet**: Observations of the Schain (1925 *a*) and Reid (1925 *b*) comets made at the Besançon Observatory with the *coudé* equatorial. On March 30 Schain's comet was of the 11th magnitude, 40″ diameter, with a nearly central nucleus. Reid's comet on March 31 was of the 8th magnitude, with nucleus 8″ diameter, tail faintly outlined.—Emile **Belot** The trajectory of the proto-sun in the primitive nebula the origin of comets — Jean **Villey** and Pierre **Vernotte** The electrical maintenance of pendulum oscillations without physical contact The oscillations can be maintained by the electrostatic attractions between the pendulum and its fixed supports An outline of the necessary conditions is given —A **Grumbach**: The surface phenomena in photo-voltaic elements with a fluorescent liquid The effect of the illumination on the electromotive force of the cell platinum—fluorescent solution—platinum has been studied The variation of potential caused by the illumination is a function of the lighting, and of the nature and concentration of the solution, but is independent of the initial electrical conditions —Charles **Chéneveau**. Some optical properties of turbid solid resinous media Opaque resins, natural or artificial, which may be regarded as the inverse of suspensions of resins in water, obey the general optical laws of turbid media containing large particles —G **Réchou** The spectrographic study of the *K* series of the heavy elements Values are given for the α_2, α_1, β, and γ lines for ten elements (tantalum to uranium) —P **Job** The spectrographic study of the iodocadmium complex The existence of the complex ion CdI_4 is proved, and the equilibrium constant k of the reaction $Cd^{++}+4I^- \rightleftharpoons CdI_4^{--}$ deduced from the measurements —A **Mailhe** The catalytic decomposition of the acid chlorides The vapours of isovaleryl, isobutyryl, propionyl, acetyl, and benzoyl chlorides were passed over nickel at about 420° C Analyses of the gases produced in each case are given —I P. **Voitesti** Faceted pebbles in the tectonic breccia in the salt massif of Roumania. —J **Savornin** Djebel Hadid (Eastern Grand Atlas) —Frédéric **Hermann** The fan of Bagnes and the Dent Blanche layer —L. **Eblé** Magnetic measurements in the centre of France The magnetic elements are given for 45 stations in the Departments of Loir-et-Cher, Cher, and Nièvre —R **Bureau** and M **Coyecque**: Atmospherics on the oceans Their meteorological characters —Henry **Hubert**. Practical problems of meteorology concerning French West Africa —P **Lavialle** The embryonic sac of the Dipsaceæ —H. **Colin** and Mlle Y. **Trouard-Riolle**: The crossing of smooth-haired black barley with rough-haired white barley (Albert barley) —A **Goris** and M. **Métin** The preventive action of anthorine towards aconitine If less than a lethal dose of anthorine is injected into guinea-pigs, followed by a fatal dose of aconitine, the animal is protected by the anthorine, but the latter has no action as an antidote after injection of aconitine. The preventive effect of anthorine persists for at least twenty-four hours — M. **Parat** and J **Painlevé**: The exact concordance of the characters of the vacuome and the classical apparatus of Golgi —Edouard **Chatton** and Mme. **Chatton**: The action of external factors on the Infusoria. The conjugation of *Glaucoma scintillans* is determined by the modification of the proportion of the constituents of a chemically defined medium.— — **Paillot**. The cytoplasmic and nuclear alterations in the course of the evolution of *grasserie* of the silkworm.—G. **Guittonneau**: The formation of thio-sulphate at the expense of sulphur by the micro-organisms of the soil.

Official Publications Received.

Field Museum of Natural History. Zoological Series, Vol. 14, No. 2. Review of Living Caenolestids, with Description of a new Genus from Chile Reports on Results of the Captain Marshall Field Expeditions. By Wilfred H. Osgood. (Publication 222) Pp. 163-173 Zoological Series, Vol. 13: Catalogue of Birds of the Americas and the Adjacent Islands in Field Museum of Natural History; including all Species and Subspecies known to occur in North America, Mexico, Central America, South America, the West Indies, and Islands of the Caribbean Sea, the Galapagos Archipelago, and other Islands which may be included on Account of their Faunal Affinities By Charles B. Cory. Revised and continued by Charles E Hellmayr Part 3. Pteroptochidae, Conopophagidae, Formicariidae (Publication 223) Pp. vii+369. (Chicago)

Department of the Interior. United States Geological Survey. Water-Supply Paper 518: Surface Water Supply of the United States, 1919-1920. Part 12 North Pacific Slope Drainage Basins. B Snake River Basin. Pp vi+318+2 plates. 30 cents Water Supply Paper 519: Ground Water in Santa Clara Valley, California. By William O Clark. Pp vii+209+19 plates. 35 cents Water Supply Paper 520-D Base Exchange in Ground Water by Silicates as illustrated in Montana. By B Coleman Renick. Pp. ii+53 72+plates 3-5 Water-Supply Paper 520 E The Artesian-Water Supply of the Dakota Sandstone in North Dakota, with special reference to the Edgeley Quadrangle By Oscar E Meinzer and Herbert A. Hard Pp ii+73-95+plates 6-7 Water Supply Paper 525. Surface Water Supply of the United States, 1921 Part 5 Hudson Bay and Upper Mississippi River Basins Pp v+191+2 plates 20 cents Water-Supply Paper 532: Surface Water Supply of the United States, 1921 Part 12 North Pacific Slope Drainage Basins A Pacific Basins in Washington and Upper Columbia River Basins Pp vi+222+2 plates 25 cents Water-Supply Paper 538 The San Juan Canyon, Southeastern Utah, a Geographic and Hydrographic Reconnaissance By Hugh D Miser Pp v+80+22 plates. 30 cents Water-Supply Paper 560-A. Water Power and Irrigation in the Madison River Basin, Montana By John F. Deeds and Walter N White. Pp ii+80 (Washington Government Printing Office)

Sudan Government Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1924. (Chemical Section, Publication No. 35) Pp 42 (Khartoum)

Report of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii for the Biennial Period ended December 31, 1924 Pp iv+49+10 plates. (Honolulu, Hawaii)

Diary of Societies.

SATURDAY, MAY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (II)

BRITISH PSYCHOLOGICAL SOCIETY (Jointly with the General and Æsthetics Sections of the Society) (at King's College), at 3.—Mrs. Ursula Roberts Intuition and Beauty.—Miss H M Wells The Influence of the Relation between Values and Choice.

MONDAY, MAY 18

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof H Wildon Carr. Review of Philosophic Tendencies since Hegel.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—N E Odell. The Physiography of Mount Everest

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London) (Annual Meeting), at 7.—P W. Thomas. Some Factors in the Choice of the Best System of Traction for Handling Dense Suburban Rail Traffic.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—G T Forrest. The Architectural Development of American Cities (Lecture).

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. W. H Moberley. Some Ambiguities in the Retributive Theory of Punishment

TUESDAY, MAY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (I.)

ROYAL STATISTICAL SOCIETY, at 5.15.—Sir Napier Shaw: The Week or Month as an Intermediate Time-Unit for Statistical Purposes.

ROYAL SOCIETY OF MEDICINE, at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions made to the Society's Menagerie during the month of April 1925.—Dr H H Scott: A Streptothrix Disease of Wallabies.—Dr. C F Sonntag A Monograph of *Oxycleropus aper*. II Nervous System, Sense Organs, and Hairs.—R. H Burne. Note on the Cerebral Arteries of the Angler (*Lophius piscatorius*).—Dr. E A. Spaul: (*a*) On the Retarding Influences of the Posterior-lobe Pituitary upon the Development of Frog-tadpoles; (*b*) Iodine and Amphibian Metamorphosis.

ILLUMINATING ENGINEERING SOCIETY (at Lighting Service Bureau, 15 Savoy Street, W.C.2), at 7.—W J. Jones and H. Lingard: A Survey of Lighting in 800 Retail Shops

ROYAL PHOTOGRAPHIC SOCIETY (Kinematograph Group), at 7.—E. Blake: Film Mutilation.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. R Ruggles Gates: Mendelian Inheritance in Man.

WEDNESDAY, MAY 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Late F. W. Harmer and C. E. P. Brooks: Further Remarks on the Meteorological Conditions of the Pleistocene Epoch.—Sir Gilbert T. Walker: On Periodicity.—Dr. H. Jeffreys. On Fluid Motions produced by Differences of Temperature and Humidity.—A. H. R. Goldie: Gustiness of Wind in Particular Cases.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. W. Tutcher and Dr. A. E. Trueman: The Liassic Rocks of the Radstock District (Somerset).—H. Dewey: Palæolithic Implements of Chellean Type from the Gravels of Hyde Park.

INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 7.30.—S. C. Downes: Mechanical Costing.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. A. Fleming: William Sturgeon and the Centenary of the Electro-magnet

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. R. Chambers: The Technique of Micro-dissection and Injection of Cells.—F. I. G. Rawlins: A Note on the Use of the Neon Lamp in Microscopy (with Demonstration by J. E. Barnard).—Dr. H. J. Ludford: The Cytology of Cancer.

THURSDAY, MAY 21.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Medical Society of London), at 2.30.—Dr J. Shaw Bolton: Mind and Brain (Maudsley Lecture)

ROYAL SOCIETY, at 4.30.—Dr W. E. Curtis and R. G. Long: The Structure of the Band Spectrum of Helium. III. The Doublet Bands.—G. S Adair: (*a*) A Critical Study of the Direct Method of Measuring the Osmotic Pressure of Proteins; (*b*) The Osmotic Pressure of Hæmoglobin and the Absence of Salts.—J. W. Fisher: Some Further Experiments on the Gyromagnetic Effect.—G A Elliott and Prof. I. Masson: Thermal Separation in Gaseous Mixtures.—*To be read in title only*:—Prof O W. Richardson: Structure in the Secondary Hydrogen Spectrum.—C N. Hinshelwood and C. R. Prichard: The Catalytic Decomposition of Nitrous Oxide on the Surface of Gold.—E H Callow: The Velocity of Ice Crystallisation through Supercooled Gelatin Gels.—R. C Johnson. Further Spectra associated with Carbon.—W Sucksmith. The Gyromagnetic Ratio for Magnetite and Cobalt.—I Sandeman The Secondary Spectrum of Hydrogen at Higher Pressures.

ROYAL SOCIETY OF MEDICINE (Dermatology Section) (Annual Meeting), at 5

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O Bower: The Natural Classification of Ferns as a Study in Evolution (I)

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—Prof. A M Carr-Saunders The History of the Limitation of Numbers.

CHEMICAL SOCIETY, at 8.—Dr. P C Austin and J R. Park: The Rotatory Dispersion of Derivatives of Tartaric Acid Part II. Acetyl Derivatives.—J. Kendall and J. E. Booge: The Stability of Additive Compounds between Esters and Acids.—J. Kendall and C V. King: Additive Compounds in the Ternary System, Acid Ester Water.—Prof. J F. Thorpe: The Nature of Unsaturation in Carbon Compounds. Part I. The Ethylenic Linkage.—E H Farmer, S. W. Switz, and Prof. J F. Thorpe. The Nature of Unsaturation in Carbon Compounds. Part II. Conjugation (cis-hexatriene).—H. J Emeléus: A Spectroscopic Study of the Combustion of Phosphorus Trioxide and of Phosphine.—E L. Holmes and Dr C K. Ingold: The Nature of the Alternating Effect in Carbon Chains Part III. A Comparative Study of the Directive Efficiencies of Oxygen and Nitrogen Atoms in Aromatic Substitution.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Lieut.-Col J Cunningham Serological Observations on Relapsing Fever in Madras.

FRIDAY, MAY 22.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street, W.1), at 8.30.—C E. Foster Pyrometry of Exhaust Temperatures of Internal Combustion Engines

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Alfred Chatterton: The Industrial Progress of the Mysore State.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Prof L S. Ornstein. The Intensity of Spectral Lines—Measurement and Theory (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. E A. Allcut: Some Tests on a Two-Stroke Cycle Oil-Engine.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. J. T. Walford The Photography of Architecture: a Thrice-told Tale.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. Thorne M. Carpenter: The Nutrition Laboratory of the Carnegie Institution of Washington and its Investigations on the Metabolism of Man and Animals.

SATURDAY, MAY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (I).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr. D. Forbes: The Climate of Brighton.

FREE PUBLIC LECTURES.

MONDAY, MAY 18.

BIRKBECK COLLEGE, at 5.30.—Sir Richard Paget, Bart.: The Nature and Mechanism of Human Speech.

WEDNESDAY, MAY 20.

SCHOOL OF ORIENTAL STUDIES, at 5.30.—Dr. D. G. Hogarth: The Origin and Character of the Hittite Civilisation. (Succeeding Lecture on May 21.)

THURSDAY, MAY 21.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. E W. MacBride: The Inheritance of Acquired Qualities.

FRIDAY, MAY 22.

BIRKBECK COLLEGE, at 5.—Prof. F. O. Bower: Personal Reminiscences of Botany in the Victorian Age—and after.



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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2899, VOL. 115]

The "Electronic Reactions of Abrams."[1]

AN acrimonious discussion has been carried on for some time past concerning the merits of a method of medical diagnosis and therapeutics generally known as the "Electronic Reactions of Abrams." Dr. Albert Abrams graduated in medicine at Heidelberg at the age of nineteen years. At thirty-seven, after many years' practice in San Francisco, he founded a therapeutic method which he called "Spondylotherapy," and six years later, in 1910, he introduced a method of diagnosis and treatment based upon a new physiological phenomenon which he claimed to have discovered and which he named "electronic vibrations." The rate of these vibrations he held to be constant for each individual, each organ, and each disease. It is measured by an Adams's "Dynamiser" in circuit with the patient or with something more or less miscellaneous belonging to the patient, his blood, sputum, saliva, or even his signature. Readings are taken according to certain changes in the abdominal percussion note of the patient or of a "subject" or "medium" interposed in the circuit with the patient's blood, sputum, or similar substance.

The "dynamiser" is a box containing three electrodes; of these the two lower, on which the specimen rests, are electrically connected to earth, while the third, which forms part of the lid, is connected in series with two (or three) resistance boxes. The first of these is called the "amplifier," while the second (and third if present) is known as a "reflexophone." From the last resistance a wire passes to another electrode held in close juxtaposition with the forehead of a normal healthy person, standing on earthed plates "facing west" and known as the "subject" or "medium." Certain areas on the abdominal wall of this "subject" are then percussed by the operator, and for each such area the first "reflexophone" is adjusted until the normal percussion note changes to "dull"; the readings of the "reflexophone" corresponding to such changes of note are known as the "rates" of "electronic vibration." Abrams's comprehensiveness was not confined to the terminology of wireless telegraphy. Sex, race, religion, as well as disease in all its varying forms and sites, had for him their proper "rates of vibration," of which they were merely the expression. So he reversed his procedure and invented the "oscilloclast," which, by producing any desired rate of "electronic vibration," might be expected to change, if not the sex, race, and religion of his patients, at least their pathological

[1] A Preliminary Communication concerning the "Electronic Reactions" of Abrams, with special reference to the "Emanometer" Technique of Boyd. Read before a Joint Meeting of the Sections of Medicine and Electro-Therapeutics of the Royal Society of Medicine, January 16, 1925, by Sir Thomas Horder on behalf of M. D. Hart, Dr C. B. Heald, Sir Thomas Horder, Lieut.-Col. H. P. T. Lefroy, W. Whately Smith. Pp. 36. (London: John Bale, Sons and Danielsson, Ltd., 1925.) 2s. 6d. net.

states. "The climax was reached with the assertion that both numbers and letters were possessed of sexual characteristics, odd numbers and vowels being feminine, while even numbers and consonants were masculine."

The "oscilloclast" is leased to practitioners for 150*l.* on condition that it must not be opened; but according to Messrs. A. S. E. Ackermann and W Clark, consulting engineers, the greater part of the apparatus is functionless, the essential part consisting of a simple rocking magnetic interrupter, which permits about a micro-ampere of current, interrupted about 200 times, to flow to the patient. There seems, however, to be some inconstancy in the contents of the mysterious box.

In the face of ridicule, and unchastened by numerous test results of the most ludicrous description, "E.R A." has become an established cult. It has taken root in England, where there is now a "small British society of doctors who employ Abrams's methods," the Society of Electronic Medicine. Nevertheless, "employment" of Abrams's methods appears to be an imperfect description, for, composed of "genuine" Abrams workers, but unsuccessful in its application to the leaders of the "cult" in the United States for information concerning the machines its members use, the Society has agreed unanimously to explore the mechanism of the instruments supplied and publish all details (*British Medical Journal*, January 10, 1925). Moreover, it is made clear that the "genuine" Abrams workers, up to January 26, had not wholly embraced the theories of the master, for "our researches (apart from treatment results) have not enabled us to say more than that an as yet undefined relationship exists between 'reactions' and disease" (*British Medical Journal*, January 31, 1925).

When the claims of the Abrams school were first reported in England, they attracted the attention of Dr. C. B. Heald, Medical Adviser to the Director of Civil Aviation. The Director authorised an investigation which resulted inconclusively. In consequence, Dr. Heald, with Lieut.-Col. Lefroy, head of wireless research at the Air Ministry, Mr. M. D. Hart and Mr. Whately Smith, who are engaged on physical research on behalf of the War Office and Air Ministry respectively, carried on the investigation unofficially. Later, Sir Thomas Horder acted as chairman co-ordinating their work.

A preliminary communication concerning the investigation prosecuted from that time onwards has now been published in pamphlet form by Sir Thomas Horder. It is an exceedingly puzzling document. While it is clear that extensive and painstaking investigations have been carried out, the report is argumentative rather than critical, deals only with a modification of Abrams's box, called the Boyd "Emanometer," reserves important parts of the evidence, and while frankly denying to the electronists any shred of justification, ethical or scientific, for their practice, gives the unfortunate impression that there is "something in it" without elucidating in the slightest degree the nature of the "something" evidenced. Boyd's "emanometer" as described by Sir Thomas Horder substitutes for the variable resistances of Abrams's box "a variable inductance and a variable condenser" in series with a "receiving plate" and a "normal human subject standing on earthed plates facing west." "An outstanding feature of the Boyd apparatus is the incorporation of earthed metallic screens, which are claimed to eliminate contamination from external sources."

The "operator" and "subject" in a series of experiments in Glasgow were "two Gallowgate boys"—*i.e.* one Gallowgate boy percussed the abdomen of another Gallowgate boy, and his verdict concerning the percussion note constituted the "result." The tests consisted in (1) the discrimination between two apparently identical substances; (2) the identification of one specific substance from among a number of others; and (3) the determination of whether a specimen exhibited was "screened" or not from the receiving plate.

Most of the results were correct, and Sir Thomas Horder, setting aside the possibility of chance, considers "the veridicity of the phenomena in question" to be fully established. But what are the "phenomena in question"? What is it that "does something"?—the emanometer, the "substance," the experimenter, the Gallowgate boys, or some unconsidered factor or combination of factors? Mr. H. St. G. Anson conducted experiments extending over a period of some five months (1) to obtain instrumental evidence of some change in the electrical condition of the subject's skin concomitant to the variation of the percussion note, and second, to obtain graphical records of this acoustical phenomenon; and (2) to eliminate the possibility of the *apparent* change in the percussion note being due to the imagination of the observers. In respect of (2) "some measure of success was obtained, but the other part of the work proved entirely abortive." Yet it is hoped that these "entirely indeterminate" results "may prove of value in subsequent investigations into the physical nature of the phenomenon which it is hoped to undertake"!

A vigorous effort should be made to remove the restrictions under which Sir Thomas Horder's committee appears to have laboured, and to push the inquiry to a conclusion with the utmost expedition. The matter as it stands does no credit to scientific investigation.

Geodynamic Problems of the Alps.

(1) *Geodynamische Probleme.* 1: *Isostasie und die ursächliche Einheit von Gebirgsbildung und Vulkanismus.* Pp. 69 + 5 Tafeln 5*s.* 3*d.* Teil 2, A: *Tektonik und Metamorphose*; B: *Die Widersprüche in der Kontraktionstheorie.* Pp. 51. 2*s.* 6*d.* Von Dr. C. G S. Sandberg.

(2) *Geotektonische Hypothesen: eine kritische Zusammenstellung.* Von Prof. Dr. Friedrich Nölke. (Sammlung geophysikalischer Schriften, No. 2.) Pp. viii + 128 5*s.* 2*d.*

(3) *Die alpine Faltung: ihre Anordnung in Raum und Zeit.* Von Dr. Hans Jenny. Pp. viii + 176 + 3 Tafeln 13*s.* 2*d.*

(4) *Geologie der zentralen Balkanhalbinsel: mit einer Übersicht der dinarischen Gebirgsbaus.* Von Prof. Dr. Franz Kossmat. (Die Kriegsschauplätze 1914–1918 geologisch dargestellt, Heft 12.) Pp. v + 198. 16*s.* 6*d.* (Berlin: Gebrüder Borntraeger, 1924.)

(1) DR. C. G. S. SANDBERG, of the Institute of Applied Geology at Munich, is well known from his geological work in South Africa, and his advocacy of the Kainozoic age of some Alpine granites. He is deeply impressed by the parallelism of folds in the crust belonging to very distant dates, and though this fact has been regarded as supporting the origin of mountains by the slow contraction of the earth, he advances a theory of mountain formation which rejects emphatically that contraction. He attributes the major earth movements to the action of isostasy, under the control of the internal heat. He considers that deep-seated thermal influences may prevent the movements that would be expected if isostatic equilibrium were due to simple changes at the surface.

The variation of the load on an area by denudation removing material from one place and deposing it in another, according to Dr. Sandberg, is counter-balanced by the accompanying thermal changes. The base of the crustal block from which a sheet of sediment has been removed is cooled by the exposure on the surface of a lower layer, and in consequence some of the molten sub-crustal material freezes on to the under side of the block and thus may counteract the thinning of the crust by denudation. At the same time the spread of the sedimentary material over the ocean floor raises the temperature of the subjacent material and leads to the base of the block being melted off, and thus the weight reduced. This process is probably one of the causes why denudation and sedimentation do not always lead to isostatic variations in level.

Dr. Sandberg further considers that in the great geosynclinals the crust becomes sodden with superheated water, which, being confined by overlying impermeable layers, produces intense pressure and, at a high temperature, causes widespread thermo-metamorphism of the rocks, while the lateral pressure produces earth movements and mountain building That these processes would operate is generally recognised by believers in isostasy, but it is doubtful whether they would have so great an effect as Dr. Sandberg considers. The weakness of his case is his denial of the contraction of the crust. He admits that mountain folding would be inevitable if the earth contracts. He reproduces Lugeon's section of the overthrust masses in the Galmhorn; and such diagrams indicate that whatever may be the ultimate cause of the pressure, the actual movements are due to lateral compression, such as would be inevitable in a rigid crust surrounding a contracting mass.

Dr. Sandberg describes some ingenious experiments on folding movements produced during the bending of sheets of clay and asphalt, but such experiments on earth structure, like statistics, though always interesting as illustrations, prove nothing. The author's work is useful by directing attention to various influences that would attend or control isostasy, but are so uncertain that little direct reference has been made to them in the literature.

(2) Diametrically opposite to the main conclusion of Dr. Sandberg is that of Prof. Nölke. His work on geotectonic hypotheses is a critical summary of the many conflicting speculations of recent years. He remarks that the problem of orogeny is without doubt the most important, and the most difficult in the whole range of geology, and he subjects all recent theories on the subject to a critical examination

In his preliminary chapter, Prof. Nölke discusses the problems of isostasy, the periodic nature of geological phenomena, and the causes of vulcanism and glacial periods. He also discusses the permanence of oceans and continents, regarding which he adopts the moderate view that though some areas of both land and sea may have been permanent throughout geological time, the variations in other parts have been too great to admit of the permanence of the chief geographical units. He also discusses movements of the pole, and concludes that they are restricted within very narrow limits. The polar and continental wanderings advocated by Wegener, he also rejects.

The main part of the volume consists of a statement and discussion of the various rival geotectonic hypotheses. Prof Nölke concludes that the geological evidence is overwhelmingly in favour of the contraction of the earth as the main cause of crustal movements and mountain formation. The work is of great value from its careful summary of current theories and judicious conclusions of their merits.

(3) The modern literature on alpine geology is so extensive, and views have been developing so fast, that works which summarise one aspect of the subject are heartily welcome. Dr. H. Jenny, of Zurich, has prepared a short monograph on the distribution of folding east and west along the Alps, and its development in time. He adopts the view that the Alps consist of superimposed "Decken," and gives ample references to the literature on their structure; but he does not give the evidence as to their composition and the correlation of the rocks on which that theory rests. But adopting it, he correlates the various "Decken" and traces their evolution.

The theory dates back to Bertrand in 1883, who, however, afterwards abandoned his contribution to its foundation. Jenny abandons Suess's view of the asymmetric character of the Alps, and adopts Kober's conclusion that their northern and southern margins are more or less symmetrical. He has traced the movements which caused the "Decken" to a period much earlier than has been generally admitted. The story of the Alps goes back to the folding and intrusions of the Carboniferous, followed by the widespread volcanic eruptions of the Permian. The Trias was a period of geosynclinal subsidence with some deep-sea deposits. The Alpine compression began, according to Dr. Jenny, in the Pennine Alps during the Dogger, when the Lebendun, St. Bernhard, and Dent Blanche "Decken" were pushed to the north. These movements were almost confined to the Pennine Alps. They were resumed in the Middle Cretaceous, with the northward thrust of the Antigorio "Decke," contemporary with a similar movement in the eastern Alps. Further widespread northward thrusts happened during the Lower and Middle Eocene in the western Alps; there the Upper Eocene was a period of rest, though the effects of horizontal compression continued in the eastern Alps throughout the Eocene Then in the southern Alps the lateral movements ceased; the Oligocene, Miocene, and Lower Pliocene were periods of faulting and fracture. In the northern Alps, however, the northward thrusts were continued and lasted until the Lower Pliocene.

The maintenance of the northern thrusts and overfolding on the northern side of the Alps while the southern Alps were subject to more or less vertical fracturing and subsidence has produced differences so important that they go far to justify Suess's claim for the asymmetry of the Alpine structure. The dynamometamorphic effects of these Decken movements are surprisingly slight. The old view of the Mesozoic age of the crystalline schists of the Alps on which so many early Alpine theories were based, has apparently gone for ever. Though Bonney is not mentioned, his conclusion that the pre-Cambrian schists are microscopically distinguishable from the dynamically crushed later beds, is fully admitted. Dr. Jenny, for example, p. 190, says distinctly that the crystalline schists are pre-Cambrian, and his account of the metamorphism of the later beds shows that the changes have not produced rocks of the type of the old crystalline schist.

(4) The correlation of the Alps and the contemporary mountains of the Balkans is considered in Prof. F. Kossmat's geology of the Central Balkans. This book is one of the by-products of the War, for it is the twelfth of Dr. Wilser's monographs on the geology of the fields of war. It includes the results of the surveys of Macedonia, Serbia, and Albania by a large staff of German and Austrian geologists, of whom twenty-two are enumerated. Their work has been scientifically valuable, as they surveyed areas which were imperfectly known, and they collected much new information on the structure of the West and West Central Balkans. The results are of especial interest in regard to the Dinaric Mountains, to the Kainozoic of Macedonia, and to the relations of the Vardar valley, which Prof. Kossmat compares to the Briançonnais in the western Alps, as it is a Palæozoic and Mesozoic belt folded in between two masses of older rocks. These older rocks continue eastward through the Rhodope Mountains into Asia Minor.

The references to the German, Austrian, and Serbian literature are full, but there is no reference to British work on the area, though some might have been quoted with advantage. The problem of most general interest is that of the relations of the Dinaric–Balkan Mountains to the Alps. Prof. Kossmat insists that the Adriatic is a geosynclinal which dates back to the Mesozoic, and confirms the view that the Dinaric Mountains consist of tectonic blocks which have been thrust from the Balkans westward and south-westward, towards the Adriatic depression. Some of the thrust blocks are described as "Decke," but they have been moved merely for a short distance by reverse faults.

The author lays much stress on the importance of some overthrusts to the south, and these movements simplify Alpine structure. Thus, for example, Prof. Kossmat explains some inversions in the Hohe Tauern, where the Trias lies under the gneiss and schist, not as due to a far transported "Decke" having been brought from some unknown southern root, but as a simple thrust to the south and south-west of the old rocks of the Tauern arc.

That the Dinaric Alps are older than the younger eastern Alps which cut across them is now well established; and the Dinaric movements accord with the direction which is predominant in the Balkans, whereas in the western Alps the main movement has been to the north. The eastern Alps are an intermediate zone, which has been complicated by the movements having taken place in both directions. J. W. G.

Modern Metallurgy.

(1) *The Science of Metals.* By Zay Jeffries and Robert S. Archer. Pp. xvii + 460. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 25s. net.

(2) *The Corrosion of Metals.* By Ulick R. Evans. Pp. xi + 212. (London: E. Arnold and Co., 1924.) 14s. net.

(3) *Cadmium: its Metallurgy, Properties and Uses.* By Dr. Norman F. Budgen. (Griffin's Scientific Text-Books.) Pp. xv + 239. (London: C. Griffin and Co., Ltd., 1924.) 21s. net.

(1) THE subject matter of the book written by Messrs. Jeffries and Archer falls under the general heading of metallography. The authors inform us that about half of it has already been published in *Chemical and Metallurgical Engineering*, and that an effort has been made to make each chapter, to some extent, self-contained. One consequence of this is that there is a considerable amount of repetition The authors are aware of this, but state that they do not consider this an objectionable feature, "since in general the material repeated is of such importance that it will stand repetition." As to this, opinions will perhaps vary, but it may be pointed out that the deformation of metals is treated in no less than six out of the twelve chapters of the book. The repetition, moreover, is not merely of the subject matter, but of the actual language used. Pages 149-50 are identical, word for word, with pages 403-5. Since the book is written by two Americans, there is a certain satisfaction in pointing out the work referred to in the above pages is English.

With the aim of the authors we have the fullest sympathy. Their starting-point is the fact that there is now a large body of scientific data as to the properties of metals and alloys but that few generalisations of fundamental importance have yet been reached, and that there is need for a proper classification and a more fundamental analysis of this knowledge. It is with this object that the book has been written. As already mentioned, the subject matter treated is that of metallography, but the authors have written a book which is not quite like any book on metallography that has yet been published. The keynote of their treatment is evident on p. 24, where they say "that there is an evident development of metallographic science in the direction of a thorough study of the constitution of matter." They are not content, however, to finish their analysis of structure where the microscope ends. They point out that the complete analysis of structure is concerned with the ultimate particles of matter, the electron, the atom and the molecule, and that it is not sufficient merely to recognise that such particles exist. Knowledge must be gained of the actual size of these particles, of their properties and their relations with one another. "In this way a mental picture can be formed of the manner in which metals are built up and of the mechanism of the changes of structure and properties which affect their utility. The knowledge which is now available of the ultimate particles is not enough to make the pictures complete and accurate, but it is enough to make them useful."

The early part of the book deals with the conceptions of electrons, atoms, and molecules. From there the authors pass to a detailed treatment of the crystalline structure of metals, the amorphous metal hypothesis, grain growth and recrystallisation, the mechanical properties of metals, compounds of metals, metallic solid solutions, the constitution of alloys, the structure and properties of aggregates, some general considerations on the hardness of metals, and finally to the hardening of steel. This is an interesting field to survey, and, speaking broadly, the authors have treated the subject matter adequately. At any rate, they have written a book which will be read and carefully studied by workers in this field of knowledge. It is clear, stimulating, and suggestive. Here and there, however, its assertions do not accord with the scientific evidence available. On p. 164, *e g*, in dealing with the deformation of single crystals, the following sentence occurs: "Any deformation short of rupture produced by an external force, disappears on removal of the force." Such a statement is decidedly wide of the facts. Again, it is surprising to notice that the iron-carbon equilibrium diagrams published on pp. 307 and 317 entirely omit the δ to γ change in pure iron and the low iron-carbon alloys. Connected with this is the statement on p. 88 that "if iron is cast it forms grains of γ iron above 900° C., crystallising with a face-centred cubic lattice." On the contrary, the iron solidifies as δ iron (with a body-centred cubic lattice) and inverts at 1410° to the γ variety.

Chapter vi. with its account of the amorphous metal hypothesis is a fair statement of the position at the present time, but the succeeding chapter on grain growth and recrystallisation is scarcely fair to those who hold that there is a distinction between these two processes. The authors maintain that "Recrystallisation is grain growth" (p. 127), and again (p. 141) they say that in their opinion "no new crystal nuclei are formed during recrystallisation"; that is, in the absence of phase changes. There is, however, definite evidence tending to show that grain growth and recrystallisation are different processes, that the former is produced by very small stresses in the metal, followed by heat-treatment, when certain crystals grow by absorbing others; while for the latter to take place much greater stresses are required, when new crystals

make their appearance in the crystal boundaries, and ultimately *all* the original crystals are destroyed by the growth of the new crystals.

Some interesting results are given on pp. 61 and 62, where it is pointed out that metals crystallising in face-centred cubes are ductile throughout a considerable range of temperature, even down to that of liquid air, and that these are the best conductors of heat and electricity. Both ductile and brittle metals are found in the body-centred cubic arrangement, while metals having the hexagonal close-packed lattice harden rapidly under deformation. The statement that "twin crystals have not been observed in aluminium" is not correct. It has been shown that, at any rate with single-crystal testpieces of aluminium, both broad or narrow twins can be obtained provided the orientation is suitable. The statement on p. 92 that the columnar grains formed when a metal solidifies in a chilled mould "are of course unstrained," is certainly not correct in this unqualified form. Such crystals very often are in a state of strain. The chapter on the structure and properties of aggregates is a suggestive survey of this subject, while the discussion of the hardening of steel by quenching contained in the last chapter is worthy of its great importance. The book is well printed and illustrated, and if it reaches a second edition, as we hope it will do, it would be greatly improved by suitable editing and some diminution in the number of repetitions.

(2) To Mr. U. R. Evans has fallen the distinction of writing the best book that has yet been written on the corrosion of metals. Some two and a half years ago he published a remarkable study, in four volumes, of metals and metallic compounds, in which he brought the most modern chemical and physical knowledge to bear on the properties of these substances. It may have been during his survey of this field that his attention was directed to the strange neglect of the scientific study of corrosion. It is only within the last twenty years that any serious attempt has been made to remedy this defect. The subject is one of great practical importance. From time to time estimates of a more or less sensational nature are published in the press as to the annual wastage of metals by corrosion. It is doubtful to what extent such estimates approximate to the real figure, but in any case it must be admitted that the loss due to this cause is very large. Moreover, as Mr. Evans points out, the evil which must have troubled mankind from the earliest times has tended to increase rather than to lessen with the passage of years. In early times, before the use of iron was general, the wastage was probably relatively unimportant, but since then, and particularly since the atmosphere has tended to be increasingly contaminated by the products of combustion of coal, the damage has been correspondingly intensified.

The first serious attempt to grapple with the corrosion problem was begun some fifteen years ago by the Council of the Institute of Metals, which set up a Research Committee charged with the task of finding a remedy for the corrosion of condenser tubes used in marine service. The more the problem was investigated by Dr. Bengough and his collaborators, the more did it become obvious that a wider and more fundamental knowledge of the nature of corrosion was required. From 1916 onwards this investigation was financially assisted by the Department of Scientific and Industrial Research, and a year ago the Department itself set up a committee to deal with this subject on the broadest lines. This committee is now at work. The impetus given in this way to the study of corrosion has extended to other bodies and other workers, and the literature concerning it is now large. Accordingly, the time was ripe for an attempt to be made to gather the scientific principles governing corrosion into a single volume.

This attempt has been made with signal success by Mr. Evans, and it is no exaggeration to say he has lifted the whole subject on to a new plane. He says, with truth, that "many chemists and engineers still seem to consider that it is impossible to find any guiding principle in corrosion. They appear to regard the destruction of metals as a more or less capricious phenomenon not governed by fixed laws in the same way as ordinary chemical reactions. Recent research, however, has shown that it is quite possible to explain why corrosion is set up at certain places and not others" This claim he justifies in his book. It opens with a historical survey and deals briefly with the earlier theories, namely, the "acid," the "hydro-peroxide," and the "electro-chemical." Attention is directed to Aston's notable paper published in 1916, in which it was pointed out that the reason why wet rust promoted further rusting was not that it acted as a cathodic contact material but as a diaphragm, screening the underlying metal from the direct access of oxygen. This led to the newer electro-chemical theory of corrosion, according to which electric currents are set up mainly by lack of uniformity in the distribution of oxygen, a theory which gives a rational explanation of many corrosion phenomena.

Succeeding chapters deal with the direct chemical combination of metals with non-metals, the passage between the metallic and ionic conditions, anodic corrosion by means of an externally applied current, corrosion involving the production of hydrogen gas, and corrosion involving the presence of dissolved oxygen. In view of its wide practical importance, a special chapter is devoted to the corrosion of copper and its alloys. Corrosion and tarnishing in a moist and polluted atmosphere and factors affecting the velocity of corrosion are next treated, while the last

two chapters are concerned with the various methods which have been devised for the minimisation and prevention of corrosion.

Mr. Evans himself is a research worker in the field of corrosion, and this fact gives his book a peculiar value, since it is written with a first-hand experimental knowledge of the subject, and many of his examples are taken from his own researches. There is no doubt that he is fully justified in adopting this course since there is great value in describing accurately phenomena which one has actually observed. The literature of corrosion contains many theories representing many points of view. Until recently something could be said for most of these, but with the clarification of the subject which has taken place particularly in the last two years, a considerable simplification of hypothesis and theory has been rendered possible, and to this Mr. Evans has himself greatly contributed. We congratulate him unreservedly on his book, and we think it will be heartily welcomed by all those for whom it is intended—the practical engineer, the works chemist, and the investigators engaged on research into corrosion and allied subjects.

(3) Dr. Budgen has written a useful book on the metal cadmium. It is the first of its kind which has appeared. Prof. Turner, who has written a foreword, states that cadmia was known to the ancients, and that metallic cadmium has been produced for more than a century. The present annual output of the metal is about 150 tons. It is mainly a by-product in the metallurgy of zinc and lead. This production could be considerably increased if more extended uses for the metal could be found. At present, however, its applications are of a minor character. It has considerable merit as a pigment but is too expensive for common use. Dr. Budgen considers there is a hopeful field of application in the anti-friction metals and in solders, as a substitute for either part or whole of the tin. The metal is being increasingly used in the form of a cadmium-copper alloy for telephonic, telegraphic, and power transmission purposes. The present volume constitutes a comprehensive digest of the available information with regard to this metal.

The early chapters of the book deal with the sources, metallurgy, and statistical information of the metal. Then follows an account of its physical and chemical and analytical properties, and this is succeeded by chapters on the binary, ternary, and quaternary alloys. Later chapters deal with the electrodeposition and uses of the metal. The book is included among Messrs. Charles Griffin and Co.'s well-known metallurgical publications. It is well printed and illustrated, and both author and publishers are to be congratulated on its appearance. H. C. H. CARPENTER.

Science and Religion.

(1) *Science and Creation: the Christian Interpretation.* By the Rev. Charles F. D'Arcy. Pp. vi+126 (London: Longmans, Green and Co., 1925.) 3*s.* 6*d.* net.

(2) *Contributions of Science to Religion.* By the Rev. Shailer Mathews. With the Co-operation of William E. Ritter, Robert A. Millikan, Edwin B. Frost, Edward B. Mathews, C. Judson Herrick, John M. Coulter, Ellsworth Faris, Charles H. Judd, John M. Dodson, Charles B. Davenport, E. Davenport, C.-E. A. Winslow, Horatio Hackett Newman. Pp. vii+427+5 plates. (New York and London: D. Appleton and Co., 1924.) 12*s.* 6*d.* net.

(3) *New Light on Genesis: or Creation during Descent in the Scriptures.* By the Rev. Morris Morris. Pp. 151. (London, Edinburgh and New York: Marshall Bros., Ltd., 1924.) 3*s.* 6*d.*

(1) THESE admirable lectures by Dr. D'Arcy, Archbishop of Armagh, display a notable capacity for keeping abreast of recent advances in science. On p. 17, for example, we discover the author's acquaintance with the new anthropological theories of the Perry, Rivers, Elliot Smith school; he realises that culture degradation as well as progress has often taken place, and that the modern savage may not be by any means the equivalent of early man, so that the universal myth of a Golden Age may have its historical foundation after all (p. 14). The bishop also displays boldness, as well as clear judgment, in rejecting the specious attractions of vitalism in biology. It is not many religious apologists who would have dared to write words which might have come from Mr. Julian Huxley:

"The general conclusion is that, whether with the physiologist we consider the actual processes of the living body, or with the biologist we consider the evolution of living forms, the whole tendency of recent scientific discovery is in favour of the mechanistic view of the processes of life and against the vitalists who think it necessary to postulate a Specific Life Force" (p. 49).

Dr. D'Arcy does not make it quite clear whether it is only the thoroughgoing vitalism of Driesch that he is rejecting, or whether he repudiates also the modified, or "methodological" vitalism of Dr. J. S. Haldane; but his discussion of hormones and glands leads one to imagine that he stands for a completely mechanistic physiology. It may be asked how, if one accepts such a point of view, room can be found for ideas of "purpose." His attitude seems to be similar to that of R. F. Hoernlé (to whom, however, he does not refer), or to that of L. T. Hobhouse; the formula of the

former being "mechanism *plus* teleology," and of the latter, "we should not distinguish mind and matter as two substances, but teleology and mechanism as two modes of action."

The bishop's view is the legitimate one that function precedes structure. This may seem "Lamarckian nonsense," and leading back to all the superstitions of vitalism, but in point of fact it is an attempt to explain the evolution of structure by the experience which we have, in our own persons, of the actual modification of neural structure. Of this we actually have experience whenever we acquire a new habit, as neurologists like Sir Charles Sherrington and Dr. Henry Head have shown.

This part of Dr. D'Arcy's work will attract the biological student who has an interest in the philosophical implications of his science, but the psychologist will not find so much here to interest him. This is a pity, because the "conflict between religion and science" has largely shifted from biological on to psychological ground. Though a biological attitude necessarily leads to an equivalent psychological attitude (*e.g.* vitalism in biology means animism in psychology), yet we should have liked to hear Dr. D'Arcy's views on the bearing of the new psychology (and for that matter, the new anthropology) upon religion. "We are just getting the guns into position" is what one anthropologist is said to have remarked, and it is what a number of psychologists believe These sciences seem to many people very menacing to religious faith; and the bishop does not help us much here. Nevertheless, we are grateful for a courageous, sincere, well-informed, and well-written book.

(2) Dr Shailer Mathews' work has a very ambitious scope. The book is composite, and numerous authorities explain their own sciences and show how these have no hostile bearing upon religion. There are also some essays on the practical value of the natural sciences. Dr. Mathews contributes a valuable introduction, and four final chapters on religion as a personal adjustment to environment. It is to be hoped that this volume, so encyclopædic in the information it contains, and so broad in outlook, may be widely read in the United States.

(3) As for Mr. Morris Morris's "New Light on Genesis," biologists will suppose that the strength of his argument must lie in his exegetical chapters, whereas students of the Pentateuch will imagine they must lie in his criticisms of Darwin. We shall always lament that writers like Bateson, disappointed in their rather extravagant expectations from Mendelian theories, have given the impression that evolution was itself discredited, that is, that the *fact* of evolution, and not merely its *mode*, was in doubt. Mr. Morris Morris solves the problem of the origin of variations by saying (p. 40) that they were supernaturally caused. But this is to offer a different type of explanation, and to introduce a different type of causality, from that which we have become accustomed to regard as scientific. It is equivalent to saying that there can be no scientific explanation. But this is to dogmatise; and men of science will not willingly take refuge in that *asylum ignorantiæ*.

J. C. HARDWICK.

Our Bookshelf.

Les Échinodermes des mers d'Europe. Par Prof. René Koehler (Encyclopédie scientifique: Bibliothèque de Zoologie) Tome 1. Pp. xiii + 362 + 9 planches. (Paris: Gaston Doin, 1924.) 16·50 francs.

HAVING published an excellent volume on echinoderms in the series "Faune de France" (see NATURE, vol. 107, p. 776, August 18, 1921), Prof. Koehler now undertakes to provide working naturalists with a guide to the echinoderms of Europe, both the littoral species and those that live on the continental plateau, as well as a few of the more interesting forms that have been dredged from greater depths Since no such work has previously been published, the present one by so distinguished an authority will be warmly welcomed. It is to be in two volumes, of which this first one comprises the Asteroidea and Ophiuroidea, which are represented by 65 and 60 species respectively. The work is faunistic and essentially descriptive. Keys abound, and there are nine plates crowded with admirable photographs taken by the author and supplementary to those in the "Faune de France."

We have checked the accounts in various places, as occasion offered, and find them thoroughly practical. Here and there are statements that might be criticised. It is, for example, surprising to find so learned a zoologist still regarding the supposed *dorso-central* as a primary element in the echinoderm skeleton, and, what is worse, calling it the *centro-dorsal*—a totally distinct structure. He should also know that the term *ambulacra* was not given because of any connexion with locomotion. Or, to take a question of nomenclature, it is not clear why *Gorgonocephalus caput-medusæ* (Linnæus) should yield to the later synonym *G. lineki* (Müller and Troschel). Probably Prof. Koehler, who always gives 1841 as the date of Forbes's "History of British Starfishes," has not discovered that it was published in six monthly parts from October 1, 1840, to March 1, 1841. This may not be without importance. Such lapses as these, however, do not detract from the practical value of the book.

Preceding the systematic portion are some interesting chapters on the general morphology, development, phosphorescence, mode of life, parasites, and distribution of living echinoderms. The chapter on their palæontology is not quite abreast of modern views, but the notes on methods of preservation should be useful. At present rates, the book is remarkable value for the money. F. A. B.

The Ideal Aim of Physical Science: a Lecture delivered on November 7, 1924, before the University of London, at King's College. By Prof. E. W. Hobson. Pp. iv+34. (Cambridge: At the University Press, 1925.) 2s. net.

PROF. E. W. HOBSON has published in this booklet a lecture which he delivered in the autumn at King's College, London, and which is very well worth publication. He expounds briefly but clearly the view of the nature and necessary limitations of science, which received its most systematic development from Auguste Comte, but which Comte himself referred in germ to Hume. Mach, Karl Pearson, and Prof. Hobson himself are the most notable recent advocates of it, and it must be held to have made its case good, subject to a clearer definition of its meaning and limitation than have been given to it by some of its defenders in the past, not excluding Comte himself.

We keep "explaining" in science, pushing our explanation further and further back. What do we mean by "explanation"? On this point those who become interested in Prof. Hobson's pamphlet should go on to Meyerson's "Explication dans la science," where this very point is submitted to a most searching historical examination. How far does this descriptive theory of science itself involve metaphysical elements, that very reasoning about the nature of things in themselves which it seeks most carefully to exclude? What do we mean by the "nature of things-in-themselves," and what would be the basis of philosophy if it is to be so sharply severed from science as Prof. Hobson demands?

Broadly speaking, while agreeing with him in his general thesis, on the basis of the old ideas of a separate, metaphysical world of things-in-themselves, we cannot agree that the spheres of science and philosophy can be thus regarded as independent. Philosophy is rather the "science of sciences," the most general conclusions of all which we can reach, while pursuing the strict path of science as the school to which Prof. Hobson belongs would describe it. But this is far too large a subject for a short note. Prof. Hobson's pamphlet is an admirable provocative to further thought, and concludes with an enlightening account of Einstein's work as illustrating his general position.

F. S. MARVIN.

Martin Arrowsmith. By Sinclair Lewis. Pp. 480. (London: Jonathan Cape, Ltd., 1925.) 7s. 6d. net.

IT is not often that a novel calls for review in a scientific journal, but Mr. Sinclair Lewis has given us in "Martin Arrowsmith" a work of such interest and importance that notice of it should not be neglected. It is a long novel dealing with the life problem of a young medical student and practitioner in the United States, who is handicapped by the common difficulty of narrow financial straits. He is inspired by the fine fire that consumes the true research worker to the exclusion of all else, and perpetually has to fight his superiors, who demand practical results and cannot see the importance of fundamental research *per se*. If the book brings home to any of the public the force of this idea, as it surely must, then it will do a very great service to research.

The other characters are remarkably well drawn, and though the "two-fisted fighting poet Doc" Pickerbaugh, of a State Public Health Service, may appear somewhat of a caricature to British eyes, doubtless he has his prototypes in the newer civilisation of America. Max Gottlieb, the bacteriologist, is excellent, and his gospel of truth so well set out that it should be an inspiration to many others who choose the hard paths of research as it was to Martin Arrowsmith.

What is called the "human interest" is not neglected, but we can see that Mr. Lewis was much more interested in the relation of Martin's emotional life to his work than to the mere story of it; viewed only as a tale, however, it makes excellent reading.

In a preliminary note, the author acknowledges the help of Dr. Paul de Kruif afforded him with the medical parts of the work, and with his scientific philosophy, and we can only say we should be glad to meet this gentleman. Mr. Lewis showed great promise in his earlier work, but here he has surely found himself, and we have no hesitation in strongly recommending this book to all research workers. W. P. K.

Über Wärmeleitung und andere ausgleichende Vorgänge. Von Prof. Dr. Emil Warburg. Pp. x+106. (Berlin: Julius Springer, 1924.) 1·40 dollars.

THE idea of making the theory of heat conduction in solids serve as an introduction to the theory of all diffusion or levelling processes is a good one and saves a large amount of repetition of mathematical work. The use of the term thermal resistance (p. 11) in the same sense as its analogue electrical resistance is another good feature of the book. More use of the point source is made than has been customary in books on heat conduction, *e.g.* the heat section of Riemann-Partielle Differential-gleichungen. In applying the elementary theory to cases like the deposit of dew (p. 32) and the bolometer (p. 34), in which the conditions are not such as to give direct conductivity problems, the author has detracted somewhat from the value of his work for teaching purposes. The same may be said of the transition from the periodic flow of a temperature wave into the earth to the periodic change of concentration at electrodes through which an alternating current enters a solution (p. 55). Only a page (p. 64) is devoted to diffusion, and no hint is given as to the motion of the solvent. Viscosity gets twenty pages, too many of which are devoted to the old oscillating disc method.

Islands: West Indian—Ægean. By Sir Arthur E. Shipley. Pp. xii + 139 + 24 plates. (London: Martin Hopkinson and Co., Ltd., 1924.) 6s. net.

SIR ARTHUR SHIPLEY has reprinted in this volume a number of short newspaper articles which he contributed to the *Times* and other journals on a recent visit to the West Indies, and a cruise among the islands of the Ægean Sea. Tropical agriculture takes a prominent place in the volume, but other interests find a place. There is enough in the brief volume to make the reader ask for more, but all too little to satisfy. The chapters on the Mediterranean Islands especially are tantalisingly hurried.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Quantum Radiation.

THE fraction $x/(e^x - 1)$, by which the quantum theory of radiation differs from the classical theory, is so important that it seemed of interest to study it for its own sake. I accordingly wrote to my brother Alfred Lodge, as a pure mathematician, asking him what he had to say about it. He directed my attention to some points which may be of interest to other students of Planck's theory as expounded in Great Britain by Dr Jeans. First, that the function was studied by John Bernoulli and expanded in a series involving his particular numbers; and next, that it is the ratio of simple interest to continuous compound interest for the same period. Or in other words, the compound interest $h\nu$ on E, the actual basic energy, is equal to the simple interest on RT; so that E has to be reduced below the average value in order to allow compound interest to be taken on it, while the rate of interest, x, is apparently dependent on the ratio ν/T.

The expansion spoken of above runs thus:

$$\frac{x}{e^x - 1} = 1 - \frac{1}{2}x + \frac{1}{6}\frac{x^2}{2!} - \frac{1}{30}\frac{x^4}{4!} + \frac{1}{42}\frac{x^6}{6!} - \frac{1}{30}\frac{x^8}{8!} + \ldots,$$

the coefficients being the successive Bernoulli numbers. A peculiarity of this series is that there are no odd powers of x after the first; looking as if everything outside classical mechanics depended on square numbers, like the radii of Bohr orbits.

Apart from the expansion so well known to pure mathematicians, the physical suggestion is that while RT is the average energy per degree of freedom per atom, the actual individual atomic energy E accumulates continuously at compound interest, the rate of which is $x = h\nu/RT$, until some atom has attained the extra accumulation $h\nu$, which it then emits. So that $E(e^x - 1) = RTx = h\nu$

Interest is compound until it is paid, and then begins again. Thus E is first left to grow until it equals Ee^x, then $E(e^x - 1)$ is given out, and E is left to grow again until it again equals Ee^x, when another dividend is paid.

The accumulating unit is the atom, the energy of which is RT or $3RT$ only on the average. The actual energy rises by the compound interest of thermal agitation, until an emission occurs from those which on the ground of probability have reached the critical stage. small emissions at low frequency, large emissions — if they can occur—at high frequency.

The energy E is presumably internal electronic energy, the only kind of disturbance which can affect the ether and either radiate or absorb. It is doubtless associated with some particular frequency of revolution or internal vibration. Mere molecular or mechanical energy alone would not radiate (matter alone has no link with the ether); if it did we should have the equi-partition law and its troubles. Even the internal mechanism does not radiate save in jumps or jerks. Within the atom the energy grows continuously, but it is given out spasmodically.

All this is suggestive, and may probably be put in an educational manner. I need scarcely emphasise the singular beauty of the modern theory of black-body radiation, and the fundamental way in which we are beginning to get down to the mode of interaction between matter and ether.

OLIVER LODGE.

May 9.

D. C. Miller's Recent Experiments, and the Relativity Theory.

EVIDENCE against the validity of the relativity theory was unfolded before the annual meeting, April 28, of the National Academy of Sciences by Prof. Dayton C. Miller, of the Case School of Applied Science, who, by a much-refined and improved repetition of the so-called Michelson-Morley experiment, has shown that there is a definite and measurable motion of the earth through the ether.

Prof Miller has obtained on four occasions a small positive effect at Cleveland, namely, the equivalent of a velocity of about 2 kilometres per second at the altitude of the Case School of Applied Science, and about 3 kilometres per second on the level of the neighbouring hills. Whereas at the altitude of the Mount Wilson Observatory, in four consecutive experiments spread out over four years, he obtained with increasing precision a positive result of 10 kilometres per second, his last result this April justifies him in asserting that the result is correct to within one-half kilometre per second.

The technical details of these experiments themselves will be described shortly in special papers by Prof. Miller himself. The purpose of the present letter is to say a few words about the implications of these results from the point of view of the relativity and the ether theories.

In the first place, then, this definite result is entirely antagonistic to the Einstein relativity theory, which in fact could not be adapted to the results of Prof. Miller by any conceivable modifications, unless the very fundamental principles of Einstein's theory were given up. This, however, is as much as to say that Miller's results knock out the relativity theory radically.

In the second place, from the point of view of an ether theory, this set of results, as well as all others previously discovered, are easily explicable by means of the Stokes' ether concept, as modified by Planck and Lorentz, and discussed by the writer in a *Phil. Mag* paper (1919).

Without entering into the mathematical details associated with this statement, we may say only that Prof. Miller's results, as obtained in Cleveland and Mount Wilson, are given immediately by the main property of such an ether, namely, to adhere almost completely to the surface of the earth, and therefore to share almost entirely its translational motion over its surface, and to have a gradually increasing velocity relative to it when we go higher and higher up.

In the third place, the result of the recent *rotational* terrestrial experiment at Clearing, Ill., near Chicago, which gave a full effect associated with the spinning motion of the earth, can be accounted for by making the natural assumption that our globe, being almost perfectly spherical and having a purely gravitational grip upon the ether, does not appreciably drag it in its rotatory motion. Also the deflexion of the light rays around the sun to the amount claimed by the Einstein formula can be easily accounted for by means of a compressible ether provided its dielectric constant is related to its density and pressure by a very simple formula published by me a few years ago in the *Philosophical Magazine*.

The amount of additional evidence for the reality of Prof. Miller's beautiful results afforded by his tables

showing the relations of the observed azimuths of drift to the sidereal time is very remarkable. These tables indicate a motion of the solar system in a direction and with a velocity in good accordance with the independent results obtained by Dr. Strömberg and others.

LUDWIK SILBERSTEIN.

Washington, D.C., April 30

Phylogeny as an Independent Science.

UNDER the title "Phylogeny as an Independent Science," E. W M. gives in NATURE of December 20, 1924, a critical review of my "Geschichte der Organismen." Some points in this review cannot be passed without comment.

Almost at the beginning, the reviewer sums up the tenor of the book in the words. the author "treats of the evolutionary history of every phylum both in the animal and in the vegetable kingdom!" He has thus neither learned from the title, preface, and contents of the book, nor communicated to the reader of the review, the fact that "Geschichte"—that is, history—is not identical with "evolutionary" history In my mind, the history of organisms tends to follow three courses, namely: (1) a simple account according to the chronology of the fossils and to the recent changes of fauna and flora; (2) showing the superiority of differentiation and centralisation (integration, Herbert Spencer), in contrast with the inferiority of differentiation alone; (3) phylogenetical connexion, the latter being the hypothetical part of the history. Thus the reviewer apparently did not understand that this mode of treatment leads, among other things, to securing, for his part, in good cases phylogeny more dependent than hitherto on empirical chronology, and to gain perhaps here or there an adaptation to each other of isolated phylogenetical hypotheses.

Furthermore, the reviewer enumerates two themes, of which he laments the absence of any attempt at explanation in the book. Well, the law of recapitulation is by no means explained in detail, but "the value and the limitations of the evidence from fossils" is discussed in a distinct manner in what to me is one essential respect, namely, that, on the average, the number of fossils diminishes at an accelerated rate when we go down to the older geological formations, and that, where it completely vanishes in pre-Cambrian times, we are still in a period approximately recent relative to the periods of origin of life, as well as of forming the chief branches of the genealogical tree.

Concerning the phylogeny of the Turbellaria, the reviewer says: "Not a word is mentioned of Lang's brilliant theory of their derivation from Ctenophora . . .," etc. This theory, however, is mentioned in the book, pages 305-6, in the chapter on the Ctenophora, in some twenty lines, where I say that it seems to me "somewhat too distinct." Moreover, the more recent view of Wilhelmi, perhaps not yet known to the reviewer, is recorded and adopted. The same theory is briefly mentioned again on page 659, in order to compare the hypothetical place of the creeping ctenophores with that of the dipnoid fishes and that of the Bennettit plants.

The reviewer remarks, "how ill-founded is Franz's comparison of the cystid and the echinoid because both have a spherical shape." The book, however, says that probably the echinoids were derived "from cystids with five short arms." Therefore, according to my meaning, these cystids, besides the ancestors of those known as fossils, were not spherical, as also in the greatest number of fossils the arms are only broken off.

With this, to be sure, I do not wish to deny that the reviewer's objection, that the sucker of attachment of asterid larvæ is identical with the attachment of the stalk of the crinoids, can be right; and here again, if I may add in short a phylogenetical consideration, I should not believe Bury's and the reviewer's phylogeny of the Echinodermata to be persuading, nor should I mean that F. Mueller's and the reviewer's interpretation of the Nauplius (ancestral) is more suggestive than mine (modified metatrochophora). As to the Echinodermata, I do not understand how it can be overlooked that by far the greatest probability is in favour of the origin of the radiometry of this great phylum in fixation, since fixation has effected all other radiometry, or, at any rate, nearly all others, in the animal and vegetable kingdom, and since Balanoglossus, the creeping allied form to the echinoderms, is not radial. There is a striking parallelism: annelids→brachiopods, enteropneusts→echinoderms, if we assume that the non-radiometry of the brachiopods has caused lower vitality or victoriousness and the less modulation of these animals also fixed, compared with the echinoderms. To present such ideas, connected with each other, though in many cases partially hypothetical, and surely to be in future again adapted to the considerations presented from other points of view, is to be one of the tasks of the "history of organisms."

As to the Nauplius, the identification, though only approximate, of a living marine larva with a Cambrian fossil would be strongly against the tendencies of the book, and to the intentions of the author Moreover, I see no essential resemblance between the four-segmented Nauplius and the multisegmented Cambrian Marrella, without regard to the question whether this interesting form, perhaps nearly the missing-link between branchiopods and trilobites, could have been mentioned in the book.

V. FRANZ.

Zool. Inst. and Phylet. Museum,
Jena.

I AM sorry if I misunderstood the objects aimed at by Prof. Franz's book, "Die Geschichte der Organismen." I admit that the German word "Geschichte" is capable of being understood in two senses, namely, (1) a general descriptive account, and (2) evolutionary history. Since Prof. Franz holds the chair of phylogeny in his university, I understood "Geschichte" in the latter sense. All I can say is that if he intended it to be understood in the former sense, a task of such gigantic dimensions could not be attempted in a work of the size of his book. I gather that he intended to bring phylogenetic hypotheses into relation with fossil discoveries; in this aim I am in entire sympathy with him, however little success may have attended his efforts.

The object of my review was thus to point out that phylogenetic theory must remain a matter of personal taste, until the foundations on which it should rest are discussed and defined. These foundations are, as it seems to me, three, namely:

(1) When a number of closely allied species or genera are compared together, the more specialised amongst them have been evolved from the more generalised.

(2) When a close succession of allied fossil forms has been discovered in the same locality, becoming gradually changed as we pass from older to younger beds, this indicates a true evolutionary series.

(3) When the same larval form is found in the life

histories of diverse members of the same great group, it represents in modified and simplified form a common ancestor; and when the youth forms of certain members of a group closely resemble the adult forms of allied members of the same group, then these youth forms give the original structure of the allied species.

Now (1) is still able to shed strong light on the course of evolution when used with great care by our systematic experts; but its value is far more limited than was formerly supposed; its use implies that one living adult form has remained unchanged whilst other allied ones have progressed or degenerated, and this assumption is an exceedingly dangerous one, as leading palæontologists like my friend Dr. Bather have repeatedly pointed out. One has only to read Huxley's "Invertebrate Zoology" to see to what amazing conclusions the use of this method led even such a sagacious zoologist as Huxley fifty years ago.

(2) was regarded by Huxley as the best and most conclusive evidence for evolution, and in this I cordially agree with him. Its range, however, is excessively limited. Such series are known only in a few cases; and only animals with hard parts intimately related to their general organisation can give by their fossil remains any real information as to the course of evolution. It does not help us at all with soft-bodied forms like Turbellaria and Annelida, and even in the case of Mollusca it gives no information as to the course of the evolution of the internal organs. Moreover, as Franz himself admits, the fossil record begins abruptly at a time when the main phyla were already differentiated.

(3) has the widest range of applicability *if the biogenetic law is sound*. But no one, even the most enthusiastic supporter of recapitulation, has denied the action of secondary simplifications and modifications in changing life history; and it seems to me that the task of a professor of phylogeny should be to analyse and discuss these secondary modifying factors.

Such factors are, for example:

(1) The changes involved in transforming a larval into an embryonic type of development.

(2) The distorting effects of yolk and of maternal nourishment by a placenta.

(3) The tendency to represent in life history only the functionally more important organs of the ancestor and to leave the less functionally active entirely unrepresented.

Now I may briefly allude to the cases cited in my review where Prof. Franz arrived at what I consider to be erroneous conclusions owing to the neglect of these principles.

These are the origin of the Turbellaria, the descent of Echinoids, and the significance of the Nauplius larva in Crustacea.

(1) Lang's theory of the origin of Turbellaria from Ctenophora is based on a careful comparison of the *larvæ* of the two forms, and that Ctenophora can take up creeping habits and become profoundly modified in the way in which Lang suggests is demonstrated by the recent genera Ctenoplana and Cœloplana. The latter of these has a "ctenophoroid" larva as Kumai has recently proved. The opposing theories favoured by Prof. Franz are based on crude comparisons of the *adult* forms of Turbellaria and Mollusca.

(2) Prof. Franz is mistaken in supposing that my main objection to the supposed cystid origin of Echinoids is that this theory is based on the superficial resemblance of a globular shape in the two groups. *The Cystid is a Pelmatozoon*, that is, a form which typically has a stalk for attachment situated in the centre of the aboral surface opposite the mouth. *The Echinoid when young is an Asteroid*, the globular shape is non-existent, and the radial canals stretch horizontally outwards from the mouth. The globular form develops as it grows older. I speak from constant observation as I have Echinoids undergoing metamorphosis in my laboratory every year. At no period in the life history is there an indication of a fixing organ in the aboral region. In the Asteroidea such an organ is developed on the *oral* surface.

(3) The Nauplius larva represents in some form a common ancestor of the Crustacea, since it appears in life histories of members of such divergent groups as the Euphausioidacea, the Malacostraca, the Cirripedia, the Copepoda, the Ostracoda, the Cladocera, and the Branchipoda. It possesses few visible segments, but it is already an arthropod with stiff cuticle and jointed legs moving like oars, in this respect differing from all Annelida. It is, however, not a crustacean, for by definition the Crustacea have *two* pairs of præoral appendages and at least two pairs of limbs converted into jaws, whilst the Nauplius has one pair of præoral appendages and no true jaws. The Trilobita were Arthropods of just these characters; they had a single pair of antennæ, and all the post-oral limbs were alike, each provided with the rudiment of a jaw-blade but none converted into jaws, and all the limbs were of a simple foliaceous character. Now in Marrella as described by Walcott, which belongs to one of the oldest fossil faunæ known, we find the Trilobite antenna, but amongst the post-oral appendages the first two corresponding to the Naupliar post-oral second antenna and mandible *are greatly enlarged forked limbs*, whilst the more posterior limbs remain in their primitive foliaceous condition. Except for these latter limbs Marella *is* a Nauplius, and the absence of the hinder undifferentiated limbs in the modern Nauplius larva would surprise no one acquainted with comparative embryology. Since, moreover, Marrella is intermediate in structure between Trilobita and Branchipoda, as Prof. Franz justly asserts, this constitutes one more argument for regarding it as the ancestor of Branchipoda and of Crustacea in general which is represented in ontogeny by the Nauplius.

E. W. M.

The Orientation of Stonehenge.

SOME persons have supposed that the intentional orientation of Stonehenge is a theory invented by Sir Norman Lockyer. As a matter of fact, it has been the opinion of every authority who has dealt with the subject from an astronomical point of view for the last two hundred years.

Owing to the gradual change in the obliquity of the ecliptic, the point on the Stonehenge horizon at which midsummer sunrise occurs is, in the course of time, slowly shifting to the eastward. At some time in the remote past the point of sunrise, viewed from the Stonehenge site, would have been beyond the azimuth of the axis line on the northern side. The midsummer sunrise now occurs to the east of the axis line, having passed that azimuth some thousands of years ago.

At some date in the past, therefore, the midsummer sunrise undoubtedly occurred at a point on the horizon in line with the axis of Stonehenge. This is not a theory, but is an absolute astronomical fact depending on the physical constitution of the solar system.

It is generally agreed as probable that the builders of the present structure of Stonehenge directed its axis, as nearly as they were able, to the point on the

horizon at which midsummer sunrise occurred at that date.

To enable us to discuss intelligently the probability of an *intentional* orientation by the Stonehenge builders, it is necessary in the first place to ascertain the approximate date at which midsummer sunrise actually occurred in line with the axis. This problem has been dealt with from time to time by different experts, and most completely by Sir Norman Lockyer. The methods adopted for this investigation are set forth in the present writer's recently published work on Stonehenge, in the chapter on "Astronomical Considerations," to which the reader is invited to refer.

On the data there set forth Lockyer found the obliquity of the ecliptic which would cause midsummer sunrise to take place at a point on the horizon on the line of the axis to be 23° 54′ 30″. According to Simon Newcomb (the eminent American astronomer) the date at which the ecliptic made this angle with the equator was about 1840 B.C.

Owing to want of precision in the data Lockyer considered that the possible error might affect the date to the extent (plus or minus) of as much as 200 years. We may conclude, therefore, that—as determined by astronomical considerations—the date at which midsummer sunrise occurred on the line of the axis of Stonehenge was sometime between 2040 B.C. and 1640 B.C.

Now it will be observed that this is just about the date now generally agreed by archæologists as the probable date of the building of Stonehenge.

We may conclude, therefore, that the builders of the present structure of Stonehenge did, as a matter of fact, direct the axis of their new building, either exactly or very nearly, to the point on the horizon at which the sunrise at midsummer then took place. It may, of course, be contended that this remarkable agreement is a mere chance coincidence. The fact, however, remains as stated.

The accuracy of Sir Norman Lockyer's calculations has never been questioned, and the results obtained can readily be checked by any competent computer. The margin of error (200 years either way) appears sufficient to allow for any want of precision in the data.

E. HERBERT STONE.

The Retreat, Devizes,
May 1.

A Stranded Cetacean.

A BRIEF account of the stranding of a Cetacean in the neighbourhood of Langness, Isle of Man, will probably interest many readers of NATURE. This event was reported to me and my colleagues on Saturday, May 9, and in the afternoon of that day I accompanied Mr. J. R. Bruce to the spot, which is a small creek on the Langness peninsula. Here we were joined by Mr. P. M. C. Kermode, Curator of the Manx Museum, Douglas, and along with him we obtained a good series of measurements and photographs. From these we conclude that the specimen is a rorqual (Balænoptera sp.), but this identification awaits confirmation. From the measurements obtained I select the following: Length, from tip of upper jaw, along back, to notch between tail-flukes, 48 ft. 6 in.; breadth of tail, from tip to tip of flukes, 11 ft. 8 in.; tip of upper jaw to centre of eye, 9 ft. 8 in.; length of pectoral fin, anterior insertion to tip, 5 ft. 6 in.

H. C. CHADWICK.

The Biological Station,
Port Erin, Isle of Man,
May 11.

Lightning.

EVER since I was a child I have heard of the idea that lightning makes a "swishing" noise when one is quite close to it, but I have looked on this as a popular superstition. I have recently, however, had occasion to wonder whether there may not be some foundation for the idea. On April 24 there was a very severe thunderstorm here, quite a number of flashes having been within a kilometre and a half of this house; a barn was struck one kilometre away, and probably also a cottage 450 metres in another direction. During the storm three men were working in a field; two of them were together close to a holly tree in a hedge, there was a very bright flash of lightning, with a just perceptible interval between the flash and the thunder. At the moment of the lightning there was quite a loud swishing sound in the holly tree, as though, they said, a sudden blast of air went through the tree; the sound occurred definitely before the thunder.

At about the time of the occurrence the wind rose to 30 miles per hour and gradually fell off to about 13 miles per hour, both men, however, are positive that there was no wind at the time, but that it got up shortly afterwards when the rain began. The flash must have been very close as they both smelt "sulphur"—nitrogen peroxide, and they could scarcely see anything for some moments. The third man was about 230 metres away and was close to an oak tree to which he had his back, he says that when the flash came there was a noise in the tree as though it were "on fire." He turned round expecting to see that it had been struck, but neither oak nor holly showed any signs of having been struck. Is it possible that in the neighbourhood of a flash, brush discharges may take place from trees and other points?

C. J. P. CAVE.

Stoner Hill, Petersfield, Hants,
May 12.

Decay and Regeneration of Radio-luminescence.

IT is well known that the luminescence produced in certain materials subjected to the action of the radio-active rays decreases with time and that the colour of the luminescence changes, while at the same time the material itself also changes in colour. From experimental work covering more than two years and still under way, we are led to believe that the decrease in luminescence of phosphorescent zinc sulphide, etc., is probably due to the masking of the radiation luminosity by the colour which the material acquires, due to the action of the radiation.

For example, small glass tubes containing radon initially glow quite brightly with a yellowish-green light, but the glass soon turns either brown or blue, and in the course of a few days the tubes glow very faintly, if at all. If the tubes be heated sufficiently just to discharge the coloration, the glow returns. This operation can be repeated with no apparent change in the property of the glass to glow under the action of the radon rays.

The coloration of the glass is not a surface phenomenon, and the colour produced, whether brown or blue, seems to reach a colour depth beyond which further radiation produces no apparent increase in the coloration.

Since the observation of the behaviour of glass under radiation and the restoration of its luminescence by discharging the coloration by heating, phosphorescent zinc sulphide has been investigated. Here again the visible radio-luminescence and the

phosphorescence decrease as the coloration increases, and eventually zinc sulphide, which originally gave a brilliant phosphorescence in daylight, no longer responds, and it is only faintly responsive to alpha radiation However, on heating this zinc sulphide just sufficiently to discharge the coloration, no difference in any of its properties can be detected between such revived zinc sulphide and some of the same material which has not been subjected to radiation.

This investigation is being continued and a more detailed report will be given later.

CHARLES H. VIOL.
GLENN D KAMMER
ARTHUR L MILLER.

Radium Research Laboratory,
Standard Chemical Company,
Pittsburg, Pennsylvania,
April 13

Hydra and the Tadpoles.

THE following observation was made by Mr J T Wadsworth, the steward of the zoological laboratory in the University of Manchester.

On April 25 a tadpole in a small aquarium was seen to be behaving in an unusual way It was swaying to and fro with its head down, and appeared to be attached to the side of the aquarium by its tail. Further observation showed that it had been captured by a hydra and was held securely by the tip of its tail The movements of the tadpole became feebler and feebler, and in half an hour they ceased altogether, the tadpole being evidently dead or completely narcotised A quarter of an hour later, as no further signs of vitality appeared in the tadpole, the hydra with its enormous prey was carefully detached from the side of the aquarium and preserved in Carnoy's fluid

The accompanying illustration (Fig. 1) is a repro-

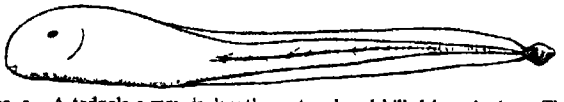


FIG 1.—A tadpole 9 mm in length, captured and killed by a hydra The hydra is seen in a contracted condition, attached to the tip of the tadpole's tail ×8

duction of a careful drawing to scale made by Miss M. Jepson of this preparation As this is the first recorded case, I believe, of a tadpole of this size (9 mm. in length) being captured by a hydra, it is probably not a common occurrence. The question might, therefore, arise as to whether the tadpole was in a normal healthy condition It may be remarked that, as the hydra was attached to the glass about half-way between the surface and the bottom of the aquarium, the tadpole must have been captured while swimming, and when first observed the movements of the tadpole were fairly vigorous. In any event, it is a very remarkable illustration of the strength of the hydra's grasp and probably also of the toxic powers of the nematocyst fluid

SYDNEY J HICKSON

University of Manchester,
May 4.

Rainfall Correlations in Trinidad.

IN connexion with my communication to NATURE (February 7, p 192) on the above subject, it may be of interest to mention that I have recently received a letter from my friend, Dr Preston E. James, Department of Geography, University of Michigan, informing me that at the meeting of the Association of American Geographers at Washington last December, he recorded in an address on "Geographical Factors in the Trinidad Coconut Industry" certain correlations between rainfall and coconut yield. In connexion with data obtained from a large estate in the extreme south-east of the island, he found a positive correlation between the rainfall of one six-month period and the *quality* of the nuts six months later, "quality" being a matter of the proportion of selected nuts—which will not pass through an iron ring 4 inches in diameter—and "rejects" and "culls" —or those that will. (This grading into "selects" and "culls" is the recognised commercial practice where coconuts, as nuts and not as copra, are exported to northern markets.) Dr. James claims to have found a positive correlation of $0{\cdot}733 \pm 0{\cdot}072$. The correlation for the same six-month period, that is, without any lag, was $0{\cdot}508 \pm 0{\cdot}109$

In my communication to NATURE, which dealt mainly with my own investigations in regard to rainfall and cacao yields, I gave the impression that rainfall and coconut yields had not been studied, being unaware of Dr James's work, which has not yet been fully published

Dr. James's work evidently constitutes a useful contribution to our knowledge of Trinidad's economic geography, and I presume that it is of considerable botanical interest to learn that the size of the coconut (not the entire drupe, but the endocarp and endosperm) is closely associated with rainfall, and that the extent of the relationship has been statistically determined under certain conditions

W R DUNLOP.

34 Kensington Court,
London, W.8, March 26

On the Spark Spectrum of Tungsten in a Helium Vacuum Arc.

PROF O W RICHARDSON, in a paper entitled "The Striking and Breaking Potentials for Electron Discharges in Hydrogen" (Proc Roy Soc 106, p. 640, December 1924), comments on the interesting fact that when a barium coated cathode burned out in an atmosphere of hydrogen, the spark lines of barium were developed instead of the arc spectrum

We have observed a very similar phenomenon in which a hot tungsten cathode used in the operation of an arc at low pressure in pure helium is capable of developing the spark spectrum of tungsten. The conditions necessary for the development of this spectrum do not require temperatures high enough to burn out the filament, but the lines invariably make their appearance when it is raised to dazzling incandescence either by the thermo-ionic bombardment of the helium, or by a direct heating current, or preferably, by both. The relative intensities of the lines are distinctly modified from those given in the standard tables of wave-lengths, which fact is doubtless to be attributed to the presence of helium. For this reason, one has to go to some pains to be certain that the lines are those of the tungsten spark spectrum. Mr. S J. Metzler has recently, in this laboratory, established this fact beyond a doubt.

Because of the wide use of the spark lines of refractory metals as secondary standards in wave-length determinations, and the difficulties encountered by various workers in this important field, with respect to precision determinations of these wave-lengths, due to pole effects and pressure shifts, it may be that the production of the spark spectra of these substances in helium vacuum arc conditions will enable them to be used with much greater reliability.

HARVEY B. LEMON.

Ryerson Physical Laboratory,
The University of Chicago, April 22.

The Story of the Mont Blanc Observatories.

By Dr. A. E. H. TUTTON, F.R.S.

THE announcement of the death of Joseph Vallot, the founder and director of the permanent observatory on Mont Blanc, at the age of seventy-two years, at his residence in Nice, will doubtless render the following account of some special interest. After I had made a particularly memorable ascent to the summit of Mont Blanc in magnificent weather on August 9, 1923, spending some time, both on the ascent and on the return to Chamonix, at the most welcome refuge and observatory of M. Vallot on the rocks of the Rocher des Bosses, at the height of 14,312 feet—it was obvious that the veteran mountaineer and scientist was in failing health—I was fortunately able to persuade M. Vallot to put the salient facts regarding the Mont Blanc observatories in writing. M. Vallot responded most kindly, and prepared a typed and signed statement, which is now of such interest and importance that it has been freely translated and embodied, with some additional facts of earlier date, in the following account. Indeed, M. Vallot gave special permission, almost a request, that its essence might be contributed either to NATURE or to the Royal Astronomical Society, and it is with great pleasure that this account is now at last written, although the sad circumstance of M. Vallot's passing from the magnificent scene of his life-work on Mont Blanc, in the valleys around which he will be greatly missed as a munificent friend and benefactor, renders the occasion one which the scientific world will deplore.

The summit of Mont Blanc, the highest point of Europe, 15,782 feet high, is a dome of snow absolutely unbroken by rock of any shape or kind. It is large enough to accommodate three or four parties of climbers at a time, of not more than four on each rope. When M. Eiffel made his celebrated sounding of its depth, for the purpose of deciding how the summit observatory of M. Janssen was to be erected, he excavated a tunnel or trench 150 feet long and 50 feet deep without touching anything but snow and hard ice, so that the depth of the snow cap must be immense.

It will be recalled that Mont Blanc was climbed for the first time by Jacques Balmat and Dr. Paccard (who reached the summit perhaps an hour after Balmat) on August 8, 1786, ascending by the Montagne de la Côte, where they spent the night at the edge of the glacier, the Grand Plateau, and the Rocher Rouge. The next year it is a tradition that Balmat again ascended it on July 5, with two Chamoniards, Cachat and Tournier. But whether that be fact or not, on August 1, 2, and 3, 1787, Balmat conducted to the summit the well-known savant H. B. de Saussure, accompanied by his valet and eighteen guides, mostly laden with scientific apparatus. They reached the summit about 11 A.M. on August 3, and stayed there four hours while de Saussure carried out some of his contemplated experiments. But the whole party were grievously afflicted with mountain sickness. Indeed, very few of those who ascend Mont Blanc escape after passing the 12,000 feet level, as the writer, who only suffered from it once before in twenty-five years of climbing, can well testify. Next year, 1788, de Saussure more or less completed his experiments at a lower level, in a hut on the Col du Géant, where he spent fifteen days

In 1844 Prof. Bravais (so well known as the pioneer of our knowledge of space-lattices in crystals), with MM. Martins and Le Pileur, reached the summit, on August 17, and spent five hours in making observations.

In 1858 Prof. Tyndall ascended Mont Blanc and placed a thermometer with an iron stem four feet deep in the ice, in order to attempt to measure the winter cold. On August 21, 1859, he again made the ascent, accompanied by Prof. Frankland (afterwards Sir Edward), but they could not even find the thermometer. A second attempt failed through the thermometer being found broken. On this 1859 ascent the effects of solar radiation and of height on the rate of combustion were studied. Six candles were weighed at Chamonix, burnt for an hour in the Hotel de l'Union, and the loss of weight determined. The same candles were taken to the summit of Mont Blanc, and allowed to burn for an hour in a protective tent. The aspect of the flame surprised them, for it was "but the ghost of what it had been at Chamonix," being enlarged, pale, and feeble, suggesting diminished energy of combustion. Yet when the candles were weighed again after returning to Chamonix, it was found that the loss was almost exactly the same as before. The result was due to the greater mobility of the air at this great height, the oxygen molecules making up for their smaller numbers by their increased rapidity of movement.

Scientific observations were afterwards made on the summit by Prof. Hodgkinson on July 14, 1866, by Prof. Soret of Geneva on July 21, 1867, and on August 6, 1875, by M. Jules Violles of Grenoble, the last mentioned finding the temperature of the sun's rays to be 4° C. higher at the summit than at the foot of the Bossons glacier.

The ice movements at the summit were thus early recognised by Prof. Tyndall, whose thermometer must have moved some considerable distance It reminds one of a statement by Capt. Sherwill, who, with Dr. E. Clarke, climbed the mountain in 1825, that Napoleon ordered a cross to be erected on Mont-Blanc, and his command was carried out by Jean Marie Coutet. But the cross only remained erect for four hours, and in four days was thrown down and had entirely disappeared.

M. Joseph Vallot made his first ascent of Mont Blanc in 1880, purely as a climber. But in 1886 he returned to Chamonix, and made his first scientific expedition to the summit. The next year, 1887, he made another expedition and stayed three days on the summit, under a simple canvas tent, a feat of great hardihood which would have become tragic if the weather had changed from the fine spell. He obtained most valuable scientific results on this occasion, and decided to endeavour to continue them another summer in some more efficient protective building. In 1890, with the aid of more than a hundred guides who offered assistance, and a very small financial contribution from the Commune, he constructed the first observatory on the highest rock, which appeared to his judgment to offer

a good foundation for a durable edifice. It was a little flat rock, almost on the level of the snow, which goes down very steeply on the Italian (Courmayeur) side, in the little Col between the present refuge hut and the Grand Bosse du Dromadaire. The observatory proved immediately useful for experiments, and was enlarged twice, in the succeeding summers of 1891 and 1892. It was at a height of about 13,500 feet, measured about 16 by 10 feet, and was about 10 feet in height. It was divided into two portions, one for observers and the instruments, and the other as a refuge for climbers. Shortly afterwards, the climbing portion became such a nuisance to the observers that M. Vallot, at his entire expense, constructed the present separate refuge hut on the Rocher des Bosses at an altitude of 14,312 feet

Unfortunately the little flat rock on which the observatory was built proved not to be the ideal spot which it was hoped it would be, the snow-field mounted up to it little by little, and ended by enveloping the little wooden structure up to the roof, rendering it unsanitary and almost uninhabitable. M. Vallot, however, was not discouraged, but, again entirely at his own expense, had a suitable foundation blasted in a part of the Rocher des Bosses, near to the refuge hut, and re-erected his observatory there, the work lasting forty-five days of the summer of 1898 The new building, constructed on a rock with a good escarpment, could not possibly be buried in the snow, and after twenty-seven years still defies the terrible tempests which break so suddenly and so often over this mountain. Each year it has afforded to scientists who desired to use it, after arranging with M Vallot, a safe and relatively, remembering the position, most comfortable shelter in which to conduct their experiments

Prof P. J. C. Janssen, of Paris, the well-known astronomer, made an expedition to the Vallot observatory in 1890, and while there conceived the project of establishing an observatory of his own on the snow of the summit itself, in spite of the advice of M. Vallot, who tried to make him see that it is impossible to construct anything of stability on a glacier. M. Vallot says in a letter to the writer: "Janssen était un grand astronome, mais il ne connaissait les glaciers, et il a eu tort de ne pas vouloir écouter ceux qui les connaissaient. Il a voulu lutter contre le glacier, contre la nature; ce n'était pas possible, et il a eu un échec retentissant." At the request of M. Eiffel, M. Vallot lodged in his observatory the engineers and workmen sent by M. Janssen, and the observatory on the summit was constructed in 1893. A large telescope with 30-cm. objective was installed; but it was never possible to use this beautiful instrument on account of the instability of the glacier base. The meteorograph, constructed to work automatically, became frozen and entirely stopped in a few days Hence, the observers had to be content with making studies in physics and astronomical physics, analogous to those which had been carried on continuously in the Vallot observatory. An expenditure of no less than 300,000 francs (then 12,000*l.*) had been incurred, furnished by public-spirited and scientific subscribers, to obtain very slight results.

Almost as soon as it was constructed, the summit observatory commenced to sink in the snow, which began to hold it as in a cup. The building was of two storeys and about 23 feet high, and the roof formed a kind of outlook-platform, approached by a spiral stairway in a little tower. In 1900 the platform had sunk to the level of the snow of the summit, and to prevent the building being engulfed altogether, the snow around it had to be excavated away each year, in order that the upper storey might be used. But this labour soon became too considerable, and was given up in 1906. The snow then mounted over the roof, and in 1908 had covered it for a depth of more than a yard, leaving only just visible the top of the tower.

M Janssen died in 1907, and as some funds remained a committee of management was formed, and M. Vallot was made director. In 1908 a delegation met on the summit, and certified that the observatory was buried, deformed, and breaking up It was decided to abandon it, and the instruments were brought down. At the suggestion of M Vallot the salvage of the debris was decided on, and in 1909 it was dug out and transported, more or less piecemeal, to the Col des Bosses, near to the spot where M. Vallot had erected his first observatory, where it is being gradually used for firewood for the Vallot observatory and hut. The observers sent by the Committee were accommodated by M. Vallot in his observatory, which appears to be now well off for fuel, formerly a very grave difficulty

When the present writer reached the Col des Bosses on August 9, 1923, the first thing that attracted his attention was the remains of the Janssen observatory, lying clearly marked on the snowfield. A few further particulars were afforded him by M. Paul Cupelin, guide chef of Chamonix. According to the latter the summit observatory, just before being dug up, had begun to work its way out towards the Chamonix side of the mountain; its transport had been a very difficult matter, the whole of the parts being entirely carried 2300 feet of descent on the backs of porters and with the help of ropes fastened to posts driven into the steep snow slope.

The Committee was very unwilling to abandon the summit, and suggested to M. Vallot that he should utilise part of the debris to construct a small light laboratory on the summit, capable of being brought to the surface each year. M. Vallot consented, but with much misgiving. He had the little hut erected, but warned the Committee that it would not be safe against thunderstorms. The next year M. Vallot's people were able to relieve it from the submerging snow, but unfortunately his warning was but too soon verified, for an expedition which had imprudently stayed in the laboratory too long were caught in a violent thunderstorm and a member of the party was killed by lightning in the hut. The next year, 1912, no workmen could be found willing to dig out the laboratory, which was deeply submerged in snow. In 1913 it had entirely disappeared, and soundings and borings made to locate it failed to find any trace of it. Doubtless, some day, this second summit observatory will work its way out to the Chamonix side, towards which the ice movement appears to be especially directed, and remind the world of its fugitive, useful existence. M. Vallot's predictions were thus once more remarkably verified.

The impression that appears to have been current, that observers spent the year in the Janssen laboratory, is, of course, quite wrong. It was only habitable for

the short summer season, from the middle of June to the middle of September, the usual climbing season. The observers prepared all their experiments in the valley, made the ascent and possibly stayed two or three days, and then descended. The Vallot observatory is visited every year by young science graduates sent out by the Société des Observatoires, and regular memoirs are printed and published. Indeed, there is usually a waiting list of young savants eager for places in the observatory, which is remarkably comfortable considering the height. Fortunately it is likely that some members of M. Vallot's family will continue the good work, and it is only right that every credit should be given to the great and generous man, great in every sense of the word, who in 1920, at the age of sixty-six, made his thirty-fourth and last expedition to the summit of Mont Blanc, and has just passed away amid the deepest regret.

Soaps and the Theory of Colloids.[1]

By Prof. J. W. McBAIN, F.R.S.

THE subject of colloids has suffered from an excess of conflicting speculations in the absence of precise and definite experimental evidence. It is still found difficult to devise methods of experiment which will yield exact, and also unambiguous, results.

At the time when we began work in this field one of the chief recognised characteristics of colloids was their changeability and the dependence of their behaviour upon the vagaries of individual specimens. The object was thoroughly to study one typical colloid in order to supply the definite evidence required for testing or building up the theory of the subject. No general theory can be true which is incompatible with carefully established experimental evidence obtained with any one typical material

Our chief experience is that the more carefully the colloid is studied the less colloidal it is found to be Soap is a unique material for the investigation of colloidal phenomena, because it illustrates nearly all the behaviour found in other colloidal systems, and it is one of the few common reversible colloids which have a definite, simple, known chemical formula. Last and most important, all results with soap solutions are quantitatively reproducible, and, in the many cases where our results have been tested in other laboratories, the experimental data have always been confirmed. We have been able to find one precise relationship after another, so that the results are almost lifted out of the colloidal field. Nevertheless it remains true that soaps are typical colloids, and that the results are of general significance in determining the behaviour of colloids and their relationship to other states of matter.

Soaps exhibit an apparently inexhaustible variety of behaviour, and few days pass without some new and interesting observation being made. A great deal of incidental information is obtained in the quest. For example, under certain conditions twice as much soap is required for a given amount of detergent action if the soap solution is allowed to stand for a day before use. Again, Miss Laing has carried out analyses which show that the substance which accumulates in the surface of soap solutions and of soap films is not free fatty acid but an acid sodium soap, a very slight excess of alkalinity in the soap solution converting it all to neutral sodium or potassium soap.

Soap is important as a type of a great class of substances known as colloidal electrolytes. It is essential to examine carefully the evidence obtained by a study of ordinary solutions of soap, since from it follows directly a proof of the micellar theory. The essence of the micellar theory is that not the chemical molecules but aggregates of particles are the colloidal units.

It is necessary to show that hydrolysis, although always present to a slight extent, does not account for the major properties of the solutions There are only traces of free fatty acid present, and there is but little free alkali, far less than in sodium carbonate, this has been shown by half a dozen independent quantitative methods. Hydrolysis is only of importance in dilute solutions This is borne out by the fact that the hydrogen soap, cetyl sulphonic acid, has properties exactly parallel to ordinary soap in concentrated solution. Hence the major properties of a strong soap solution are due to the soap itself.

We have found that in dilute solution, soaps are ordinary crystalloids, just like common salt, and dissociate into sodium and potassium ions and simple fatty ions. Upon concentrating the solutions, however, the undissociated soap molecules aggregate to form large particles of neutral soap, that is, neutral micelles. Likewise the fatty ions unite in small groups to form a new type of particle—the ionic micelle—in which there is one free charge for each fatty ion. By changing the concentration or the temperature, all intermediate proportions of these constituents can be produced This may be summarised in the following scheme.

$$\begin{array}{ccccc} NaCl & \rightleftharpoons & Na & + & Cl' \\ NaP & \rightleftharpoons & Na' & + & P' \\ \Updownarrow & & & & \Updownarrow \\ \underset{\text{Neutral micelle}}{(NaP)_x} & \rightleftharpoons & nNa & + & \underset{\text{Ionic micelle.}}{(P')_n}. \end{array}$$

The evidence for the foregoing conception is based upon a study of osmotic effects and of electrical conductivity. The osmotic effects as exemplified by the lowering of freezing point, of dew point, and of vapour pressure, and also the minimum pressure required for ultrafiltration, are in general half the values to be expected for the same concentrations of a typical salt such as sodium acetate. On the other hand, the conductivity of concentrated solutions is fully equal to that of sodium acetate. A large mass of data obtained chiefly in the laboratories of the University of Bristol has established both these truths

If now the whole of the osmotic effect be taken as a measure of the sodium ions present, thus leaving no other crystalloidal constituent, rather less than half of the observed conductivity is accounted for. The other half of the conductivity must be due to colloidal constituents, and one of these constituents must have the same number of negative charges as there are positive ions: this is the ionic micelle. The undissociated

[1] Discourse delivered at the Royal Institution on Friday, March 20.

soap, too, must be in the form of aggregates or colloidal particles because of its negligible osmotic effect: this is the neutral micelle, and of the two it is the more important.

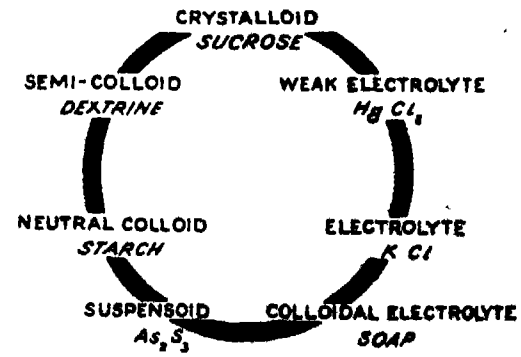
Long ago Selmi and Nägeli emphasised that not the chemical molecules, but larger aggregates, were the colloidal units out of which all larger structures are made. Nägeli in 1858 coined the word "Micell" from *mica* (a crumb), in order to have a term with no presupposition of crystal or any other particular structure. Many years of study of starch convinced him that the micelles of which these granules are composed are essentially crystalline, and now the X-ray work of Debye and Scherrer and Sponsler has shown that this is correct for such colloids as gold sols and wood.

With soaps there is no direct evidence of crystalline structure of the individual micelle, but Nägeli would have approved of the name micelle for the ordered arrangements based upon conceptions of polarity which since 1912 have become fashionable. The particles of neutral micelle in soap are found to range from a few hundred to thousands of Ångstrom units in diameter depending upon the soap and the conditions. These neutral micelles may be visualised by borrowing and modifying a suggestion of S. E. Sheppard's (NATURE, 1921, March 17, p. 73). Each particle is like a pair of military hair brushes, in which the bristles represent the hydrocarbon chains of the molecules arranged parallel to each other in sheets, two such layers being put together hydrocarbon to hydrocarbon. The two backs of the brushes on the outside represent the hydrate layer and the un-ionised electric double layer. A general survey of the facts with regard to the electrical double layers (*J. Phys. Chem.*, 1924, 28, 706) has shown that only a minute fraction of such a surface can ionise —hence the name "neutral micelle." Such a micelle would owe its stability to its internal polar arrangement of the molecules and to the external heavy hydration of the sodium and carboxyl group. The explanation of the stability of colloidal particles should be extended to the discussion of suspensoid particles where it is usually ascribed to the free electrical charges. The present conception would explain the stability by the hydration or solvation conditioned by even an undissociated double layer and at its maximum in the neighbourhood of uncompensated electrical charges. The principle here involved is the commonplace that like dissolves like, and that a particle remains in solution when it is completely surrounded or coated with chemical groups similar to those of the solvent.

The ionic micelle is more novel and is essentially different. It may be visualised by borrowing and altering a suggestion put forward by Reychler in 1914 for particles of soap, and more recently by N. K. Adam. It resembles a group of, say, less than a dozen eels tied together by the tails, and pointing outwards in all directions from the common centre. Each eel is a fatty ion with the charged carboxyl group outwards. These carboxyl groups also are probably hydrated. Such an ionic micelle cannot grow large because the electrostatic repulsion would increase as the square of the electrical charges The diameter of the ionic micelle as measured is only a few score Ångstrom units. Many experiments on migration in an electric field have shown that the ionic and neutral micelles exist and move quite independently of each other.

The conceptions put forward are a quantitative interpretation of the constitution of soap solutions and are therefore open to many kinds of direct test. One of the most cogent has been filtration (or ultrafiltration) through such a membrane as cellophane, the familiar transparent sheets of cellulose used in wrapping chocolates and certain high grades of soap. Dense membranes may be obtained through which a soap solution passes unchanged when it is in such dilution that conductivity and osmotic effect show it to be crystalloidal; that is, consisting of simple molecules and ions. The same membranes hold back all the soap, allowing only water to pass through when the soap solution is sufficiently concentrated that, according to the argument already given, the soap is entirely in colloidal form, neutral and ionic micelles. Intermediate solutions can be tested for the amounts of crystalloidal and colloidal constituents. Further, membranes with pores of any size may be obtained the diameter of which can be measured by the pressure required to blow air through them when wet; with these it is possible to hold back the neutral micelle allowing the ionic micelle to pass through. It is evident that the membranes too have a micellar structure. Again, by using a reference substance such as a salt, it is possible to measure the hydration of the colloid which is held back by obtaining a filtrate which on occasion is twice as concentrated in reference substance as the original solution. In this way it is shown that the micelle contains about ten molecules of water for each equivalent of soap.

Throughout the foregoing discussion only solutions, that is, transparent fluids, have been mentioned. The place that these colloidal electrolytes play in the general classification of all the known varieties of solutions is shown in the following diagram, where each type merges by gradual transition into the next.



TRANSITION DIAGRAM.

States of matter exemplified by soaps and their solutions.—All soaps under suitable conditions can occur in each of several crystalline forms, in two forms of liquid crystals or anisotropic liquids, and finally in certain cases the solutions previously described may set to form true transparent jellies. These true jellies are like gelatine jellies in that they are clear and elastic, and when not under strain they are isotropic; that is, dark between crossed nicols.

On the other hand, the anisotropic forms which occur in higher concentrations are not miscible with the isotropic solutions or jellies but constitute separate phases. These doubly refracting liquids are not elastic but plastic; that is, they do not quiver when shaken, small portions do not flow under the influence of gravity

but passively remain in any position or shape which is given to them. These anisotropic liquids likewise have been found to be colloidal electrolytes.

It is remarkable that, when an ordinary soap solution sets to a true transparent jelly, such properties as conductivity and osmotic effect are unaltered. It is evident that the same equilibria and the same particles exist in each. The jelly structure must be built up by the neutral micelles linking together by bonds of residual affinity (Trans. Faraday Soc., 1924, 20, 22) to form larger structures without losing their individuality. This well explains the reversible transformation of true jellies to sols.

There are at least two crystalline forms of soap, lamellar crystals and curd fibres. Both give X-ray diagrams, whilst none of the other forms of soap solutions already described give radiograms. Figs. 1 and 2 illustrate the appearance of curd fibres under the ultra-

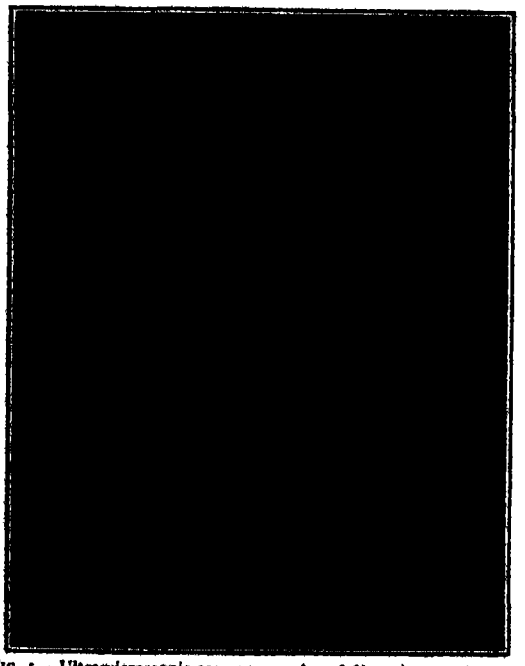


FIG. 1.—Ultramicroscopic appearance of curd fibres forming in 1 oN$_w$ sodium laurate with dark ground illumination

microscope. Fig. 3, which is strikingly similar, is taken from von Weimarn and is a similar ultramicroscopic picture of barium sulphate suddenly precipitated from concentrated solution. In all cases the curd consists of these innumerable crystalline fibres enmeshing mother liquor.

Most of the substances of the type of soaps, such as dyes, etc., exhibit many of the forms here described. Probably every soap can be brought into each of these states under suitable conditions. They exhibit a great family likeness, and the conditions differ merely in degree. All these phases are found in the two-component system water : soap, and it has been demonstrated that the phase rule applies to their equilibrium with each other. No new phases appear when salts are added.

The equilibria are surprisingly subject to law and order. Simple numerical rules relate the action of various electrolytes with each other independent of the nature of the soap. Again, simple rules hold for all soaps and their mixtures. It follows that the behaviour of the highly complicated mixtures of saponified oils and fats with various electrolytes met with in soap boiling can largely be treated on the simple basis of a three-component system. Thus by phase-rule models

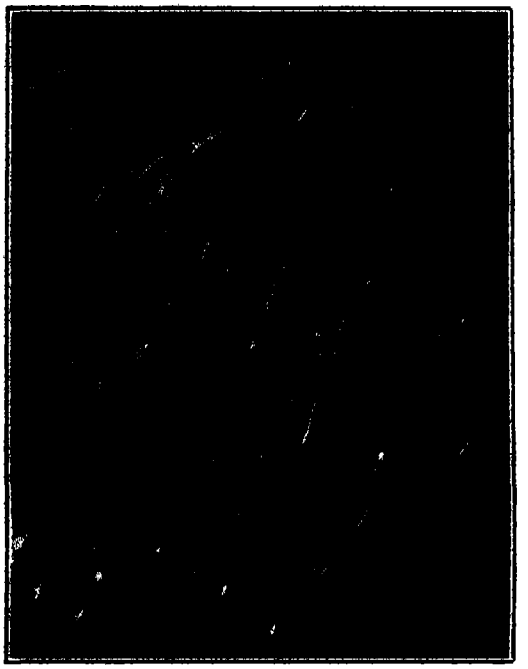


FIG. 2.—Ultramicroscopic appearance of curd fibres forming in 0 05N$_w$ sodium behenate, with dark ground illumination

it is possible to follow and predict quantitatively all the soap-boiling processes.

In conclusion, the hope and expectation may be expressed that, when various investigators have carried

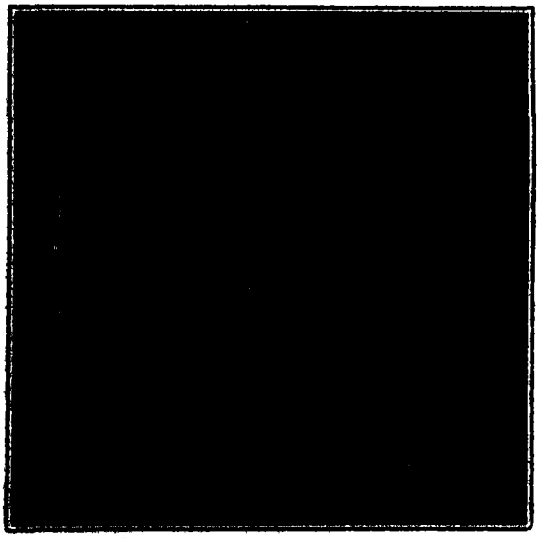


FIG. 3.—Ultramicroscopic appearance, according to von Weimarn, of gels of barium sulphate formed by sudden precipitation from concentrated solutions.

out sufficient careful and many-sided work with a number of definite typical materials like the soap which has been taken here as an illustration, the theory of colloids will ultimately become an exact science in which every statement will be demonstrable or subject to quantitative proof.

The Southampton Meeting of the British Association.

THE British Association is about to issue the preliminary programme of its annual meeting, which will be held in Southampton on August 26-September 2 inclusive under the presidency of Dr. Horace Lamb, lately professor of mathematics in the University of Manchester. Southampton, which the Association has not visited since 1882, is one of the most interesting centres in the south of England for a meeting of this kind. Its University College will house several sections of the Association, and affords an example of a great educational institution in the making The town itself is a focal point of overseas communications, and with this feature and the railway centenary of the present year in view, the programme gives special attention to various aspects of transport. This will form the subject of two days' discussion in the sections of economics and engineering jointly, while Sir Archibald Denny, as president of the engineering section, will give an address upon fifty years' evolution in naval architecture and marine engineering, and an evening lecture will be given by Mr. R. V Southwell on aeronautical problems of the past and of the future

Among other addresses, that to the physical section by its president, Dr. G C Simpson, Director of the Meteorological Office, will deal with "The New Idea in Meteorology" The address by Mr. A R Hinks, secretary of the Royal Geographical Society, as president of the geographical section, will be concerned with the science and art of map-making, a subject appropriate to the town which is the home of the Ordnance Survey Prof A V Hill, presiding over the physiological section, will speak on the physiological basis of athletic records, and this section and that of psychology will jointly discuss the acquisition of muscular skill. Mr Tate Regan, in the chair of the zoology section, will deal with "Organic Evolution · Facts and Theories." Dr W W. Vaughan, headmaster of Rugby, will address the education section on "The Warp and the Woof in Education." The sectional presidents again include a lady, Miss Lynda Grier, principal of Lady Margaret Hall, Oxford, and a distinguished economist, who will take "The Meaning of Wages" as the subject of her address to the section of economics. The speakers and subjects for other presidential addresses are · Prof. C H Desch on the chemistry of solids; Prof. W. A. Parks, of Toronto, on the cultural aspects of geology; Dr T. Ashby on practical engineering in ancient Rome; Prof. C. Spearman on the mental law of diminishing returns; Prof. J. Lloyd Williams on the phæophyceæ and their problems; and Dr. J. B. Orr on the inorganic elements in animal nutrition. Sectional lectures already announced are by Mr. J. E. Barnard, on the observation of the infinitesimally small, and by Dr. D. H. Scott, on some points in the geological history of plants.

The many subjects already entered for discussion in the sections include the cost of farming and the marketing of agricultural produce; health in schools; the functional significance of size; the ignition of gases; the botanical geography of tidal lands; variations in gravitational force and direction, and recent investigations in the modern psychological field of vocational guidance

The scientific interests of Southampton and its neighbourhood are exceptionally varied and attractive to visiting members, including the geographical and economic position of the town itself, the botanical study of the New Forest, the archæological features of Stonehenge, Winchester, and other sites, and the geological complexities both of the mainland and of the Isle of Wight General excursions will be arranged to these and to other points, including a visit to the Channel Islands after the meeting, if there be sufficient demand, and particular scientific interests will be met by sectional excursions, such as the special visit of an anthropological party to Stonehenge, and inspections of the anti-gas school and diving-tender at Portsmouth and the aerodrome at Gosport which are being arranged on behalf of the physiological section.

The Association is maintaining its policy of attracting junior scientific workers to its meetings by making it possible for them to attend at a minimum cost, and as before has invited certain universities and colleges to nominate selected science students to "exhibitions" enabling them to participate in the meeting without expense to themselves.

The programme indicates that the Local Executive Committee for the meeting will make every endeavour to assist visiting members to obtain hotel, lodging, or hostel accommodation, and a form is provided on which they may indicate their wishes. A large attendance is hoped for, especially as the opportunity for reunion was denied to many members last year by the fact that the meeting was held in Canada.

Obituary.

Mr. W. W. Rouse Ball.

WALTER WILLIAM ROUSE BALL was born in London on August 14, 1850, and was educated at University College School and afterwards at University College. He was primarily a mathematician, but his studies were not confined to one subject, for besides gaining the gold medal for mathematics in the M A. examination of the University of London, he obtained a first-class in mental and moral science in the final honours examination for the B.A degree in 1869. He commenced residence at Trinity College, Cambridge, in 1870 and graduated as second wrangler and first Smith's prizeman in 1874. He was called to the bar, and although he did not practise, he published a "Student's Guide to the Bar," which ran through many editions. He was elected a fellow of Trinity College in 1875, and was a mathematical lecturer at the College from 1878 until 1905. He also held the post of tutor from 1893 until 1905, an office for which he was admirably qualified by his methodical habits, his sense of justice, and his wide sympathies.

With the exception of a few short papers Ball's published work on mathematics relates to the history of the subject, and appeared between the years 1888 and 1893. It stopped abruptly when he became tutor, and although afterwards he wrote again, he directed his attention to new subjects. But that he still retained his interest in mathematics was shown when

in 1922 he endowed the University of Cambridge with funds for establishing a special annual lecture in that subject.

In 1888 Ball published "A Short History of Mathematics," which reached a sixth edition in 1915. It contains, along with short biographies of the more prominent mathematicians, an interesting and well-written account of the development of the subject from the earliest times to the end of the nineteenth century. In 1889 the general history was followed by a "History of the Study of Mathematics at Cambridge," which, in addition to the information suggested by the title, contains an account of the general scheme of education at the University in medieval times and explains how this gave rise to the modern system of honours examinations with their curious name *Tripos*. He was especially interested in the works of Newton, and besides a paper on "Newton's Classification of Cubic Curves," printed in the Proceedings of the London Mathematical Society (vol 22, 1891), he published in 1893 "An Essay on Newton's Principia" It is interesting to learn from the essay, along with more important information, that we may still repeat the story of Newton and the apple, for it appears to have been told by persons well acquainted with Newton, one of whom was vice-president of the Royal Society at the time when Newton himself was president In 1892 appeared the "Mathematical Recreations and Problems," which is perhaps the best known of Ball's books, as it reached a tenth edition in 1922. The subject was a congenial one, for it was his hobby to collect information about all kinds of tricks, puzzles, and paradoxes, and a small book on "String Figures," which he published later, was another illustration of this habit of mind.

Ball's later publications deal mainly with the history of the University and Trinity College. They include "Cambridge Notes," "Cambridge Papers," a short monograph on Trinity College, an account of the King's Scholars and King's Hall, and a "History of the First Trinity Boat Club." He was also engaged for many years in editing, with the assistance of Mr J A Venn, the five large volumes which contain the "Admissions to Trinity College, Cambridge."

The record of Ball's literary work is a lengthy one, but it only represents a part of his activity, for he was able to get through an immense amount of work He took his full share (and something more) of administrative work both in his College and in the University, and for the last twenty years of his life he was one of the University representatives on the Town Council of Cambridge His judgment was sound, and his advice was often sought and freely given He was a warm friend, a delightful companion, and a courteous opponent, whose temper could not be ruffled He had an especial sympathy with young people, which he retained to the last, for the same number of the *Cambridge Review* which contains his obituary notice contains also a full account of his speech at the centenary dinner of the First Trinity Boat Club. His full and active life came to an end on April 4

WE regret to announce the following deaths.

Father A L Cortie, *S J*, Director of Stonyhurst College Observatory, and Director of the Solar Section of the British Astronometrical Association from 1900 until 1910, on May 13, aged sixty-six

Mr H Ling Roth, for many years keeper of the Bankfield Museum, Halifax, Yorkshire, on May 12, aged seventy-one

Current Topics and Events.

CONGRATULATIONS are due to Sir George Taubman Goldie, K C.M.G, F.R.S. (elected 1902), who entered on his eightieth year on May 20 He is held in honour as the founder of Nigeria, the first Governor of which, Sir Frederick Lugard, appointed in 1914, was his friend and co-helper Goldie made acquaintance with the wild Niger districts in 1877, when little more than thirty years of age, but earlier he had acquired a considerable knowledge of the African continent, which stood him in good stead when new possibilities loomed on the horizon. To add to the British Empire the tracts of the lower and middle Niger, already more or less penetrated by British traders, became Goldie's creative purpose. The introduction of ordered sway by chartered companies was an early conception, and some united efforts were made. In 1881 he sought to obtain a charter from the Imperial Government, but there were difficulties. In 1884 he succeeded in buying out the French traders, and the year 1886 saw the establishment of the Royal Niger Company, with Lord Aberdare as Governor and himself as Vice-Governor The Germans, led by Prince Bismarck, were markedly antagonistic to all schemes. However, Goldie's efforts to obtain treaties with the numberless chiefs were eminently successful, and ultimately the British sphere was recognised. In 1900 the Company transferred its territories to the British Government, and by 1903 British sovereignty was acknowledged Sir George was made a privy councillor in 1898 In 1905 he was elected president of the Royal Geographical Society, holding office for three years He is an Hon D C L. (Oxon) and LL. D. (Camb), honours conferred in 1897.

LORD BIRKENHEAD, in presenting the triennial gold medal of the Royal Asiatic Society to Prof A H Sayce at a meeting of the Society held on May 12, paid an eloquent tribute to the value of the work on the archæology of the East which Prof Sayce has now pursued continuously ever since 1870 He referred to Prof Sayce's edition of Herodotus, which, as he said, might well have engaged the life of most men, and pointed out that the great new linguistic studies in the East to which he passed on restlessly and insatiably, have proved of great intellectual consequence Prof. Sayce and other scholars like him have rendered a service to Great Britain which is scarcely ever adequately measured, and never adequately rewarded, by their contemporaries. While the discoveries and sophistication of the West are not denied to the East, the reading of the incalculable minds of the East is a fundamentally more difficult task; but it has been

given to a few gifted Englishmen to understand more closely, with more sympathy, the mentality of the East than any other men in their day and in their generation. Lord Birkenhead referred in this connexion to Sir Richard Burton, and said that Prof. Sayce had achieved that learning mainly by his extraordinary gift for acquiring a mastery of Eastern languages and dialects, by an incredible degree of industry, and still more by a natural sympathy with the peoples, languages, and histories of ancient long-dead civilisations. Prof. Sayce's friends and colleagues will cordially unite in echoing Lord Birkenhead's closing words, in which he expressed a hope that Prof. Sayce, who has retained his physical strength and is now in the full maturity of his intellectual power, may enrich still further the field of human knowledge.

THE first Lister Memorial Lecture was delivered by Sir W Watson Cheyne, Bart., F.R.S., on May 14, at the Royal College of Surgeons This lecture forms part of the memorial to Lord Lister which was decided upon so long ago as October 1912. Part of the funds raised were devoted to placing a medallion in Westminster Abbey, part to the monument unveiled in Portland Place, London, in March 1924 (see NATURE, March 22, 1924, p 430), and the remainder formed an International Lister Memorial Fund for the advancement of surgery The Royal College of Surgeons of England became trustee for this latter fund, and it was resolved to award a bronze medal, with a sum of 500*l*., every three years, in recognition of noteworthy contributions to surgery Sir W. Watson Cheyne is the first recipient of the medal, and the award is particularly appropriate, apart from Sir William's scientific achievements, in that he was, with the late Sir Rickman Godlee, assistant to Lister in London. Sir William's lecture on the occasion of the presentation of the medal was a general account of Lister's aims and achievements, and the full and detailed story is promised in a forthcoming volume Lister's early work at Glasgow is passed in review, leading up to the time when he learned of the work of Pasteur on fermentation and putrescence The use which Lister made of this knowledge and the wonderful extensions of the work in surgery caused a revolution in surgical methods, for, as Sir William Cheyne says, "not only has his work led to the practical disappearance of septic diseases after operations, but it has enabled the surgeon to perform many operations which prolong life, restore movements, rectify deformities, and add to the usefulness and comfort of mankind" The complete lecture appears in the *Lancet* of May 16

THE Tennessee Legislature recently enacted a law forbidding the exposition, in any educational institution supported by public funds, of theories holding that man is descended from the lower animals. Mr. J. T. Scopes, a high-school teacher, is to be prosecuted, presumably for contravening the law (the *Times* New York correspondent says "teaching of the theory of evolution," which is not quite the same thing), and Mr. W. J. Bryan has offered his services as associate counsel. The legal offence being, it appears, admitted, the American Civil Liberties Union, with Judge Neal for the defence, will concentrate on the issue whether the State has the right to restrict theoretical inquiry (which also does not seem to be the point). The prosecution, however, we are told on the same authority, "stands ready to deal with the whole question of evolution." If this be admitted, the trial will at any rate add to the gaiety of nations. It has not yet been announced whether a rack, a thumb-screw, and the other means of compelling evidence in such cases have been provided by the State. Probably Mr Bryan's scarifying eloquence will suffice.

IN distributing electrical energy for lighting and power purposes, it is necessary to have good electrical conductors to carry the current, and also to have good insulating materials to prevent leakage and accidental damage by short-circuits. During the last twenty years the progress made by the industry in improving insulating materials has not been in proportion to the great amount of work expended on the subject by research associations in almost every country. For insulating cables, paper and fibrous materials, which are impregnated by oils and waxes of various kinds, are usually employed Their resistance varies enormously with the amount of moisture they contain, so that data obtained by measurement are practically useless unless their exact hygroscopic condition be accurately specified. Most experimenters also make the assumption that the resistance is independent of the direction of flow of the current, an assumption that can only be justified in few cases. At a meeting of the Institution of Electrical Engineers on April 23, K G. Maxwell and A. Monkhouse read a paper on recent improvements of insulation. They devoted considerable attention to the discussion of the papers and pressboards, which are widely used in practice. Much was expected of asbestos, but its capacity for taking up moisture, and the fact that it often contains conducting fibres of magnetite, militate against its use. Vulcanised fibre is shown to be one of the poorest of the insulating materials, and it is curious that it is still so widely used. The use of machine building instead of hand building has considerably improved the quality of mica products. Perhaps the most satisfactory progress has been made in improving the best quality insulating varnishes. The authors pointed out that from the commercial point of view it would well pay modern firms to train specialised operatives. Many firms expend large sums of money in obtaining apparatus for testing insulation. For testing porcelain alone, one firm is stated to have spent 20,000*l*. on apparatus.

THE difficulties arising out of the administration and control of religious trusts in India, as exemplified in the dispute over the Sikh shrines in recent years, for the settlement of which legislation is now under consideration, are illustrated further by a case upon which judgment was given by the Judicial Committee of the Privy Council on an appeal for the High Court of Calcutta, which is reported in the

Times of April 28. A wealthy Hindu who died in 1846 set up a household god and provided for its continued worship. On the reconstruction of the house by his son many years later, two houses were built and a separate house was set up for all the household gods. When on the death of the son the estate was divided under a rule of the Court into three equal shares, a house was allotted to the eldest and the youngest sons, while the second son received provision to build a house Under the scheme for the worship of the god, each son in turn conducted worship for a year; but after the idol had been taken to the second son's house on two occasions, objection was taken on the third occasion on the ground that it could not be moved from the dwelling of the household gods. Hence the litigation. The Judicial Committee decided that account must be taken of the personality of the idol, which is no mere chattel. It must therefore be represented by a guardian or a friend appointed by the Court, and further, as it is to be worshipped by both sexes, the interests of the daughters must be taken into account. A scheme of worship must therefore be framed by the High Court.

ON May 11 and 12, two lectures were delivered in the University of Oxford by Prof R Chambers, of Cornell University, on the results of his studies in micro-dissection. A description, illustrated by photographs, was given of the apparatus which has rendered possible the dissection of a single cell, and even the extraction of a single chromosome from a dividing nucleus. The same apparatus has also enabled Prof Chambers to inject solutions of various salts into living cells, with curious results dependent in some measure on the strength of the solution. The "needles" employed for the manipulation are formed of glass tubing protracted into extreme fineness, and converted, if required, into pipettes by fracture of the drawn-out end. The objects to be dissected are contained in a hanging preparation on the lower surface of a coverslip which forms the roof of a damp chamber with sides sufficiently patent to allow free play to the operating needles. Many interesting results have already followed from the use of the method, particularly with reference to the protoplasmic communication between cells without the intervention of the nervous system; the transmission of impulses controlling ciliary action; the exact points of adhesion between adjacent cells, and so on. The effects of injection upon isolated cells are striking, especially the trail of coagulated protoplasm left behind by an amœba in endeavouring to roll away, so to speak, from the point where the puncture of a pipette has admitted a minimal quantity of calcium chloride. There is little doubt that the further employment of this valuable method will lead to results of still greater importance

SOME further literature issued by the Industrial Institute (102 Belgrave Road, S.W.1) outlines the aims of that body in fuller detail. Industry consists in a threefold process, making, marketing, and financing. There is need for a central clearing house to co-ordinate data on these operations. Irregularities in the demand for goods, associated with "trade-cycles," lead to wide variations in selling prices and unemployment. It appears that the national annual savings in Great Britain should suffice to employ the present annual increase in population. Authorities of the Treasury and the Bank of England have suggested that, in determining the flow of investment, consideration should be given to the problem of employment. The committee advising on the supply of credit under the Trade Facilities Act is understood to concentrate on the support of industries immediately productive of employment. It is thought that the representative character and experience of members of the Institute should be of special value in connexion with this suggestion, and it is proposed that a special committee should be set up to consider the whole problem on scientific lines and endeavour to bring about co-ordinated effort in industry.

THE Association to Aid Scientific Research by Women announces that it has just awarded the Ellen Richards Research Grant of 1000 dollars for the year 1925 to Miss Katherine MacFarland Chamberlain, of Detroit, Michigan, U S A Eighteen theses were submitted in competition for the Research Prize, 8 of these from the United States, 7 from England, 2 from Wales, and 1 from South Africa, and while no one of these theses was, in the opinion of the experts who examined them, up to the standard set by the association for the Prize, the paper submitted by Miss Chamberlain was of such a character that the judges were unanimously of the opinion that opportunity for further research should be given to her Miss Chamberlain graduated from the University of Michigan in 1914, receiving the degree of Doctor of Science in 1924, and she is at present instructor in mathematics in the College of the City of Detroit Her work for the Prize was on "The Fine Structure of Certain X-Ray Absorption Edges," and was carried out in the laboratories of the University of Michigan between August 1924 and January 1925 A preliminary report upon this investigation appeared in our issue of October 4, 1924, p. 500. The Prize is not to be awarded again until 1927.

SIR WILLIAM H. ELLIS has been elected president of the Institution of Civil Engineers, and will take up office on the first Tuesday in November.

THE DUKE OF YORK has graciously consented to accept the honorary presidentship of the thirty-sixth Congress of the Royal Sanitary Institute to be held at Edinburgh on July 20-25, at which the Right Hon. Sir John Gilmour, Bart, Secretary for Scotland, will preside, and deliver the inaugural address. A Health Exhibition is being held in connexion with the Congress.

AT the annual general meeting of Manchester Literary and Philosophical Society the following officers were elected:—*President*, Rev. A L. Cortie, *S.J.*; *Vice-Presidents*, Prof. W. L. Bragg, Prof. H. B. Dixon, Mr. Francis Jones, Prof. T. H. Pear, *Secretaries*, Mr. John Allan, Dr. W. H. Lang; *Treasurer*, Mr.

R. H. Clayton; *Librarians*, Mr C L. Barnes, Dr. Wilfrid Robinson; *Curator*, Mr W. W. Haldane Gee.

THE next International Congress of Entomology will meet this summer at Zurich on July 19-26, with the well-known Swiss entomologist Dr A. von Schulthess as president The gathering will be representative of all branches of biology interested in entomology pure or applied, and many institutes and societies of zoology, hygiene, tropical medicine, plant pathology, forestry, etc, are sending delegates Further particulars can be obtained from the Zoological Museum, Tring, Herts, or from H Kutter, Zolliker-Str 76, Zurich 8

MR K S. MURRAY, who has been for many years the managing director of the British Oxygen Co, has been elected to the chairmanship of that Company, which has been rendered vacant by the death of Mr. E. B Ellice Clark Mr Murray will for the present continue also to discharge the duties of managing director He joined the Company as assistant engineer in 1887, and since then has been intimately associated with the development of the oxygen industry, and the remarkable industrial applications of oxygen which have taken place since the commencement of the present century

DR. F. A. F C WENT, professor of botany in the University of Utrecht, is giving at various universities in England a series of lectures under the auspices of the Anglo-Batavian Society. Went is well known for his work on the development of the Podostemaceæ and on the Triuridaceæ and Polygalaceæ He is also an authority on tropical crops, such as cocoa and sugar-cane, and on many physiological aspects of plants, *e g.* the physiology of fungi and of the irritable movements of plants His lecture in London will be given at the Imperial College of Science and Technology on Monday, May 25, the subject being "Modern Conceptions of Light Stimuli in Plants."

ACCORDING to *Science*, Dr H. S Jennings, professor of zoology in the Johns Hopkins University, Baltimore, is to receive the first Joseph Leidy Memorial Award of the Academy of Natural Science of Philadelphia "in appreciation of his researches upon the Protozoa and the Rotatoria, and in recognition of his broad knowledge and keen understanding of the significance of biological phenomena." The award was endowed by a fund created in 1923 which will provide a bronze medal and an honorarium every three years "for the best publication, exploration, discovery or research in the natural sciences."

THAT indefatigable Autolycus, the curator of the Hull Museums, has for many years been snapping up such old and unconsidered vehicles as fell in his way, from bone-shakers to hansom-cabs, and storing them in any corner he could find Hull's exhibit at Wembley last year and the emptiness of an old Corn Exchange, gave him an opportunity seized with his usual acumen and energy. "A Commercial Museum for Hull" was a good slogan, and the business firms responded admirably with exhibits and cases. But there was still space to spare, and what more suitable to fill it than the shandrydans, for "the success of a commercial community depends largely on its means of transport." So the whole was fittingly opened on April 16 by Brigadier-General Sir Henry Maybury, of the Ministry of Transport, and Mr. T. Sheppard added another item to his collection of museums.

THE Rockefeller Medical Fellowships for the academic year 1925-26 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 10. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than 350*l* a year for a single Fellow, with extra allowance for a married Fellow, payable monthly in advance Travelling expenses and some other allowances will be made in addition Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C 2

IN the notice of Mr W S Jones's book, "Timbers: their Structure and Identification," which appeared in NATURE, April 25, p 601, two corrections are necessary The genera of conifers treated are 19 in number, and not 14 as stated. The writer of the notice regrets that in some unaccountable way he overlooked the mode of distinguishing the woods of Populus and Salix, which is given in p. 73 of the book, namely, that the medullary rays are homogeneous in the former and heterogeneous in the latter genus

CATALOGUE No. 795 of "Sotheran's Price Current of Literature" has just been issued. It comprises Part VI of this well-known serial publication, and is as interesting and valuable as former parts. It gives the titles and full bibliographical details of nearly 3000 works on geology, mineralogy, crystallography, physical geography, meteorology, and microscopy, and, in addition, of sets or long runs of scientific periodicals and proceedings of scientific societies. The present part is noteworthy in that it includes the libraries of the late Prof. T. G. Bonney and Prof. G. A. J. Cole, and many volumes formerly the property of the late Sir Archibald Geikie The catalogue should certainly be obtained by readers of NATURE interested in the subjects dealt with.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Lecturers in applied mathematics, geology, and botany in the University of Durham (Durham Division)—The Head of the Department of Pure Science, South Road, Durham (May 28). A junior assistant (physical

chemist) in the Colloid Chemistry Laboratories of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (May 28). A manager recorder of experimental work in breeding poultry for table use, at the South-Eastern Agricultural College, Wye, Kent—The Secretary, South-Eastern Agricultural College, Wye, Kent. A technical assistant at the Marine Aircraft Experimental Establishment, Felixstowe—Secretary, Air Ministry, Adastral House, Kingsway, W.C 2. Inspectors of agriculture under the Sudan Government—Controller, London Office, Sudan Government, Wellington House, Buckingham Gate, S.W.1. A demonstrator in the department of inorganic and physical chemistry of Bedford College for Women—Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 3). An assistant lecturer in mathematics and geography at Bristol University—The Registrar (June 3). A demonstrator in chemistry at the London (R.F.H.) School of Medicine for Women, Hunter Street, W.C.1—The Warden and Secretary (June 6). A woman lecturer in education, in the Department of Education, Bristol University—The Registrar (June 8). An assistant lecturer in the physics department, Leeds University—The Registrar (June 15). A mistress for botany and physics at the County School for Girls, Tunbridge Wells—Headmistress. Professor of organic chemistry in the University of the Witwatersrand, Johannesburg—Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (July 15). A mistress to teach botany, chemistry, and mathematics at the North London Collegiate School, Sandall Road, N.W.5—The Head Mistress. Instructor Lieutenants in the Royal Navy—The Adviser on Education, Admiralty, Whitehall, S.W.1. A master for chemistry at Taunton School—The Headmaster.

Our Astronomical Column.

THE 13-MONTH YEAR.—Calendar reform has moved a step forward in the reply just forwarded to the League of Nations by the representatives of British railways; in this they state that they are unanimously in favour of the adoption of a year of 13 months of 28 days each with one extra day (2 in leap years) This exact equality of the months would be a great convenience from the wage point of view. The objection is sometimes made that the division into quarters would be inconvenient but our present "quarter days" are neither at the end of months nor equidistant from each other, so that the placing of them at the end of the first week of the fourth month, the second of the seventh, and so on, would be no worse than at present.

Most people who advocate the 13-month division of the year couple it with the plan of making every month begin with the same week-day, so that the days that stand outside the month would also be outside the week. However, the proposal to interfere with the regular sequence of week-days meets with strong opposition, and has little chance of adoption, but the 13-month reform would be quite useful even without this point. All the months of any year would still begin with the same week-day, but the day would change from one year to another.

COMETS.—A Harvard circular gives an elliptical orbit of Reid's Comet by Mr. Maxwell from observations extending from March 24 to April 7.

T = 1925 July 28 34 G.M.T. (new)
ω 258° 45′ 54″ } 1925·0
Ω 5 13 37 }
i 25 36 12
e 0·912875
Period 81·212 years.

Mr. G. Merton and Dr. A. C. D. Crommelin tested this period by including the observations of Mr. B. M. Peek, which extended to April 24. Their research gave a period of more than 12,000 years, so that the departure from a parabola seems to be much slighter than that announced by Mr. Maxwell. This comet is now too low down for English observers, but will come north again at the end of the year.

Very diverse statements have been published as to the date of the next return of Faye's Comet. *Popular Astronomy* gave the date as the autumn of 1924, nearly a year too early. Mr F. R. Cripps has now investigated the perturbations by Jupiter (B.A.A. Journ., vol 35, No 6), and finds Aug 6 next as the date of perihelion Major Levin and Mr. Gaddum give an ephemeris, which starts on May 15, but the distance from the earth is now so great that detection is unlikely for two or three months. Every effort should then be made to find the comet, as it has not been seen since 1910 No accurate ephemeris was prepared in 1918, astronomy being short-handed owing to the War.

THE VELOCITY OF LIGHT FROM THE STARS.—It has been pointed out by Prof La Rosa that if the velocity of a distant star compounds with that of light, the observed intensity depends upon the acceleration of the radial motion. When there is acceleration towards the observer, light which is emitted at any moment will tend to catch up with that emitted at a previous instant Thus the flux of light into an observer's eye will be greater than when the acceleration is zero and still greater than when it is negative The effect will increase with the distance of the star. In the *C.R. Acad. Sci.*, Paris, March 2, M. Salet points out that de Sitter has concluded that no such compounding takes place, on the ground that the motion observed visually or spectroscopically in double stars is a regular Newtonian one. These stars, however, are not very distant, and it seems possible that, though the velocity of the source may not compound fully with that of light, the latter may be altered to a small extent. This might produce an effect in the case of very distant stars, only the brightness of which can be observed. The brightness of Algol does not vary by 0·1 mag. in the interval between successive minima, although the radial velocity varies continuously. The conclusion is that the velocity of the emitted light is not changed by more than 1/200 of the velocity of the star. There are stars of the same type which are much fainter, and it is probable that their distances are much greater, while their radial velocities are of the same order as that of Algol; it thus becomes possible to arrive at a much closer limit for the effect, which can be regarded as negligible even for the most distant of these stars.

Research Items.

STENCIL IN FIJI.—Mr. Henry Balfour offers an attractive suggestion as to the origin of the art of stencil in Fiji in vol 54, Part 2, of the Journal of the Royal Anthropological Institute In patterning the borders of bark cloth the Fijian woman used a strip of banana leaf in which a pattern had been cut to make a stencil. Stencil is very rare among primitive peoples, and certainly does not occur elsewhere in the South Pacific It was not introduced into Fiji by immigrants, nor is it probable that it was a heritage from the Melanesian stock, otherwise it would be found among other members of that stock It must therefore be an indigenous development. If so, the idea of using perforated leaves may have been suggested by leaves naturally perforated by the larvæ of an insect. Bamboo leaves collected in the Naga Hills, which have been thus perforated before unfolding, exhibit resemblances to some of the Fijian patterns. These are always displayed transversely and never along the leaf, in exactly the same way as the perforation due to insect action If correct, this explanation points to independent invention of the art of stencil in the Pacific and in Asia and Europe

THE PERUVIAN QUIPUS —Baron Nordenskiold in a further instalment of his studies of South American Ethnography (*Comparative Ethnographical Studies*, 6, Pt I, Göteborg, Elanders Boktrycker Aktiebolag) describes a number of ancient Peruvian quipus and discusses their meaning and purpose The quipus always consist of a main cord to which are attached a number of cords, usually arranged in groups and hanging down like a fringe. To these are usually attached subsidiary cords, with sometimes a further subsidiary set. A large number of knots occur on the hanging cords but not on the main cord These knots are single or "long," *i.e.* the cord has been passed two, three, four, or more times up to nine through the loop. These knots indicate numbers in a decimal system, and comparative study points to the number 7 as playing an important part, although it had previously been held that the number 7 was seldom or never regarded as lucky or unlucky in the New World as it was in the Old World. In the early literature relating to Peru the quipus are stated to have been used for population statistics, accounts, and even memoranda of historical dates; but the fact that all that have been preserved have come from graves in association with so-called Inca pottery precludes them from having served as a record connected with the living. They must have some magical purpose connected with the dead. The subject will be considered further and in more detail in a second part of the volume to be issued later.

SKILL IN RELATION TO PRODUCTION —In the presidential address to the Société des Ingénieurs Civils de France (British Section), February 18 last, Mr. L. A. Legros took as his subject "Skill in Relation to Production." He traces the evolution of some industrial processes during the past century, showing the changes which have taken place, involving the gradual displacement of skill from the actual manufacturing processes to the repairing processes. To work a machine may demand no skill, but to diagnose where a machine is wrong and to put it right demands skill of a high order; a good example of this type of skill is the marine engineer. Mr. Legros then discusses the attitude taken up by the trades unions, particularly in the so-called ca-canny methods characteristic of some trades at the present time. He deals sympathetically with the workers' point of view, but shows where it breaks down, and is very critical of the attempt to bring down the rate of work to that of the poorest worker. The problem of monotony is touched upon, and Mr. Legros does not make the mistake of looking upon it as merely a question of repetition of movement A very interesting section is devoted to the nervousness characteristic of the very highly skilled worker, a mental factor which has too frequently been overlooked both by the employer and the less skilled worker, realisation of temperamental peculiarities would guide those responsible into alleviating the conditions of their workers. He makes a plea for the education of most boys in manual skill so that those who govern should not be looked upon as ignorant by those who work. The address is very valuable and should be read and considered by all employers, intelligent workers and educationists.

VACCINATION OF CATTLE AGAINST BOVINE INFECTIOUS ABORTION.—Attempts to protect cattle against Bang's infectious abortion by the use of vaccines consisting of dead cultures of the causative micro-organism (*B. abortus*) have been unsuccessful. L. Forest Huddleson has therefore (Technical Bull. No 65, Agricultural Experiment Station, Michigan Agricultural College) experimented with a living, highly antigenic, but non-virulent strain of *B. abortus*, with the view of using it as a protective vaccine. Several herds were treated, some of the animals in each herd being kept as controls The breeding efficiency in Herd I was 87 5 per cent. for the treated, and 33 3 per cent. for the untreated, animals; in Herd H, 100 per cent for the treated, and 75 per cent. for the untreated, animals. The results so far are encouraging, but much more work is necessary before a definite conclusion can be established.

GERMICIDAL ACTION OF ULTRA-VIOLET RAYS.—Previous investigations have been interpreted as indicating that the long wave-length limit of germicidal action is in the region of 297 $\mu\mu$. W. W. Coblentz and H. R. Fulton (Scientific Papers, No. 495. Department of Commerce, Bureau of Standards, Washington, 1924) find that germicidal action is produced by ultra-violet radiation throughout the spectral range from the very short wave-lengths (Schumann rays) to and including 365 $\mu\mu$. The shortest rays have the most violent lethal action, which decreases in intensity with increase in wave-length. The lethal action of radiations of wave-lengths longer than 305 $\mu\mu$ was found to be very slow in comparison with those of less than 280 $\mu\mu$, and ceased with wave-lengths above 365 $\mu\mu$. The energy value of the most active germicidal radiations from the quartz-mercury arc (170-280 $\mu\mu$) required to kill a bacterium is very small, being of the order of 19×10^{-13} watt.

REVERSED SYMMETRY IN SNAILS.—A type of genetic behaviour which offers some interesting anomalies is exhibited by the cases of reversed symmetry in snails. It is known that many species and genera are normally dextral, but occasionally produce sinistral individuals. Some genera are sinistral, and others still contain species of both kinds with only occasional reversal, while some species of Achatinella and Partula commonly produce both types freely. It is known that the reversal shows itself in the first cleavage of the egg, but the causes of reversal are unknown. A study of the inheritance of sinistrality in the normally dextral gastropod *Limnæa peregra* has been made by Capt. C. Diver, with Prof. A. E. Boycott and Miss

Sylvia Garstang (*Journ. Genetics*, vol. 15, No. 2), based on more than 600 broods (from hermaphroditic parents), and 53,000 young. The broods fell into six types: all dextral or sinistral, 3D : 1S, 1D : 1S, mostly S or mostly D; and all types can be obtained from D or S parents. In a closely reasoned presentation of the results, a hypothesis is reached which is too complicated to consider here, but it is assumed that the asymmetry of any individual is determined by the combined (or antagonistic) action of the chromosomes concerned, this action having a delayed effect. It is not considered that maternal inheritance will account for all the facts observed.

CRYSTALLINE MICELLÆ IN THE PLANT CELL WALL.—Taking up the micellar hypothesis, Nägeli applied it to starch and the cell wall so long ago as 1862. Steinbrinck, in the *Biol Centralblatt*, vol. 45, pp. 1-19, 1925, shows how well this hypothesis helps to explain the data now accumulating with modern technique. For some time subsequent to Nägeli, the view was warmly supported that the optical anisotropy of the cell wall resulted from a state of strain Nägeli's original observations made this unlikely, whilst Ambronn's recent observations (*Zeitschr fur Kolloidchem.*, 1916 and 1917) make it clear that in addition to the anisotropic effect due to layers of crystals with their long axes parallel, lying in a medium of markedly different refractive index, cellulose walls, and even nitrated cellulose in solvents such as celloidin, have doubly refractive properties depending upon the anisotropic qualities of the micellæ themselves. Steinbrinck now summarises the results of Röntgen ray investigation, with some photographs published for the first time, which lead to the conclusion that in hemp and ramie fibre the crystalline micellæ must be arranged symmetrically to the long axis of the fibre. In cotton wool, the diagrams obtained (by the Debye-Scherrer method) are in agreement with the assumption that the micellæ are symmetrically placed with reference to the direction of the spirals running with frequent reversals at an angle to the long axis of the hair. The fact that Katz obtains with the dry wall and with the wall after imbibition of water the same type of X-ray diagram supports Nägeli's original assumption that, in the main, the water is adsorbed into the spaces between the particles and not taken up into the micellæ. The German work summarised in this paper appears to be in very good general agreement with the work upon similar problems published in recent years by Dr. W. L. Balls and his colleagues (NATURE, June 21, 1924, p. 910).

CONTROL OF DISEASE IN CROPS.—The Natural History Survey of Illinois has been engaged for three years on the accumulation of a complete catalogue of the bacterial and fungus diseases present on the more important crop plants, together with their distribution throughout the State, the results to date being published by L. R. Tehon in Bull. 4, Vol. 15, Division of Natural History Survey. The diseases are grouped according to the crops that are subject to them, those of cereals, forage crops, fruit, vegetable and field crops and of a few commonly grown ornamental plants being dealt with in turn. In the text is given a brief description of the disease, a short summary of its history in Illinois, a statement of its distribution as now known, and a statement of the usual methods of control. This information is graphically illustrated by a comprehensive series of maps giving the distribution of each crop and of each disease described in the various counties of the State. In addition, the statistical figures are set forth in forty-two tables, many of which give the estimated reduction in crop caused by the various diseases and the financial loss resulting therefrom, together with various observations on susceptibility and percentage of infection with different varieties in various districts. For the 44 crops investigated, 115 serious diseases are tabulated, with 50 of a less virulent type. For 16 of the serious diseases only, the average annual reduction in crop for wheat, oats, corn, apple, peach and pear is estimated as 56,398,929 bushels, the average annual loss being 44,452,053 dollars. These figures would doubtless be multiplied many times if it were possible to estimate the loss due to the remaining 49 serious diseases and the damage done by the 50 less serious ones, but, as it is, they are sufficiently large to impress on all cultivators the importance of adopting as widely as possible the approved methods of prevention and control advocated in the bulletin.

JURASSIC ECHINODERMS OF SINAI.—The late René Fourtau made many contributions to the palæontology of the echinoids of Egypt; at the time of his death in 1920 he had completed a memoir on the Jurassic echinoderms of Sinai, which has now been published by the Geological Survey of Egypt (Catal. Invertébrés foss Égypte, Terrains jurass., 1, Echinodermes, 1924) The Jurassic deposits in North Sinai, from which the fossils were obtained, were discovered in 1913-14, and the Mollusca have already been described by H. Douvillé, who concluded that the horizons represented are Bajocian, Bathonian, Callovian, and Oxfordian Fourtau finds evidence of the presence of deposits of later date, the Lusitanian. The echinoids are represented by 43 species belonging to the families Cidaridæ, Salenidæ, Diadematidæ, Echinidæ, Holectypidæ, Cassidulidæ, and Dysasteridæ. The crinoids belong to the genera Apiocrinus, Millericrinus, Pentacrinus, and Cyclocrinus. Altogether 52 species of echinoderms have been found, of which 19 appear to be peculiar to Sinai, while 27 are identified with species already known in the Jurassic deposits of western or southern Europe.

PETROLEUM IN UGANDA.—The occurrence and possibilities of development of petroleum are discussed in a report issued by the Uganda Geological Survey, by E. J. Wayland. The report is divided into five sections, embracing history, geology, petroleum, the Lake Albert field, and recommendations regarding exploration for oil. Four appendices are added, dealing with the outline geology of Uganda, the Kaiso bone beds, the origin and significance of Lake Albert petroleum, and notes on Lake Albert itself The critical oil geology of the region centres round Lake Albert, a depression forming part of the Great Rift Valley system. The floor of this depression is in crystalline rocks, and on these rest a great thickness of shallow water sediments divisible into two groups separated by an unconformity, the lower series are thought to be of Miocene age, while the upper have been shown palæontologically to represent late Pliocene or early Pleistocene deposition. The sedimentary rocks show a general tilt to the N.E., and locally have been folded into anticlines running parallel with the valley sides. Seepages of oil have been located in three places, at Mswa, Kibero and Kibuku, and the report recommends exploratory boring to test the petroleum possibilities of this Albertine depression, more particularly what is known as the Waki dome. The author states that "the presence of seepages . . . indicate that oil has been formed in enormous quantity in the Lake Albert depression; but not the slightest evidence has been found to show that either volcanic or tectonic processes have

played a part in its production" While the existence of seepages can never be, on general technical grounds, any criterion of magnitude of oil formation, the last part of that statement is indeed significant. The author's recommendations for exploration are carefully worded, though we fear that the "Rift Valley storehouses of petroleum," even if existent, are more likely to be found empty than full; we wish it were otherwise.

SWEDISH METEOROLOGICAL RESEARCH.—The publication of the data for 1917 of the observatory at Abisko in Swedish Lapland gives a complete series of observations from 1917 to 1922 (*Observations météorologiques à Abisko en 1917*, Upsala, 1924) The observatory has particular value as being one of the most northerly in the world, lying about two degrees north of the Arctic circle The hourly records are given in full throughout the year, but there is no comparison with other years Another valuable publication deals with the flow and temperature of Swedish rivers (*Hydrografiska mätningar i Sverige*), and is published as Part 5 of the year-book of the Statens Meteorologisk-Hydrografiska Anstalt.

ATOMIC DISINTEGRATION.—The *Physikalische Zeitschrift* of November 15, 1924, contains an account of work by Drs H Pettersson and G Kirsch, of the Vienna Institut fur Radiumforschung, on this subject They describe their earlier methods, by means of which they claim to have observed atomic fragments with a range so low as 10 to 12 cm; and they criticise the results of Bates and Rogers, which tend to show that radium-C gives off α-particles with ranges of 9 3, 11 2 and 13 3 cm. in addition to the normal ones with a range of 7 cm, and would make the observation mentioned above impossible Frau Dagmar Pettersson has investigated the problem and is of opinion that these long range α-particles do not exist. The methods used are based on the author's explosion theory The particles which fly off from the disintegrated atom in a direction at right angles to the original path of the α-particle are observed, and by means of these it has been possible to measure the maximum range of H-particles from carbon, about 6 cm. Using a small ring of thin copper, activated on one side with radium-C, the α rays from which fall on the substance to be investigated, it is possible to observe particles thrown off in the retrograde direction on to a zinc sulphide screen, with ranges so low as 11 mm

A HOT WIRE APPARATUS FOR MEASURING HIGH ALTITUDES.—An apparatus described by MM. E Huguenard, A Mangan, and A Planiol in the *C.R. Acad Sci.*, Paris, March 16, employs two batteries, one of 16 and the other 18 volts, in series, the hot wire being connected between the positive pole of the first and the negative of the second, and an adjustable resistance R between the other two poles The two negative poles are connected by a voltmeter, and R is adjusted so that the voltmeter reads zero when the pressure of the surrounding air is 760 mm. When the pressure is reduced, the temperature of the environment remaining constant, the convection from the hot wire diminishes, its temperature increases, the electrical balance is disturbed, the voltmeter deviates, and it is possible to determine experimentally the relation between deviation and pressure. If R is made of wire which has the same temperature coefficient as platinum, the readings may be rendered independent of the surrounding temperature. The sensitiveness of the apparatus to change in height increases as the pressure diminishes, and is about 1·8 times as great at about 14,000 metres altitude as at the surface of the earth. With a barometer, on the other hand, the variation in reading for the same increase in height is about 4·4 times less at 14,000 metres than at the surface, so that the hot wire instrument at this altitude is eight times as sensitive as the barometer.

RADIO-FIELD INTENSITIES.—The Austin-Cohen formula used in radio-telegraphy gives as nearly as can be measured the radio-field intensity of the waves due to an antenna, after passing over salt water and during daylight, for distances up to about 5000 kilometres, provided that the frequency of the emitted waves lies between 60 and 1000 kilocycles. This corresponds to wave-lengths lying between 5000 and 300 metres Several experimenters have stated that for greater distances and for higher or lower frequencies its inaccuracy is so large that it is practically useless For long distance communication, frequencies so low as 15 kilocycles are sometimes used In this case various observers have found that at a distance of 6000 kilometres the ratio of the observed to the calculated value of the radio-field intensity is about two to one. In order to get more trustworthy data, L W. Austin has made some trans-pacific measurements of radio-field intensity, and has published the results in the Journal of the Washington Academy of Sciences for April 4, 1925. Observations were made at San Diego, California, on the radio-field intensity of the signals emitted from Cavite and from Malabar, Java. The distance from Cavite to San Diego is 11,800 km. and the time difference is eight hours. This gives about two hours for observations in September without approaching the time of sunrise or sunset too closely. The distance from Malabar is 14,700 km., with a time difference of nine hours. On account of the weakness of the signals in comparison with atmospheric disturbances, a maximum inaccuracy of about 20 per cent. was possible. The final results show that when the observations were made in daylight, the observed value of the field strength of the signals from Cavite were about three times the value found from the Austin-Cohen formula, while the observed strength of the Malabar signals was about twice the calculated value. The frequency of the Cavite signals was 19 34 kilocycles (wave-length 15,500 m.), and of the Malabar signals 18·98 kilocycles.

ATOMIC WEIGHT OF BORON.—A recent redetermination of the atomic weight of boron has been carried out by H. V. A. Briscoe and P. L. Robinson and is described in the March issue of the Journal of the Chemical Society. The ratio $BCl_3 : 3Ag$ was determined, the materials being very carefully purified. The final results gave an atomic weight of 10·82 for boron derived from Europe and Asia Minor and 10·84 for boron derived from North American deposits. The question is raised as to whether this difference is due to different proportions of isotopes in the two samples.

DETECTING COMPLEX IONS.—A method of determining the presence or absence of complex ions in solution is described by W. H. Patterson and J. Duckett in the March issue of the Journal of the Chemical Society. The miscibility temperature of two liquids (critical solution temperature) is elevated by the presence of impurities. This elevation is approximately a linear function of the concentration of the added salt. In the case of salt pairs, additive values for the elevation imply that neither complexes nor double molecules exist in the solution. Deviations from the separately calculated values measure the molecular complexity.

Institut International de Chimie Solvay.

THE second of the triennial chemical conferences under the Ernest Solvay Trust was held in Brussels, on April 16-24, at the Fondation Universitaire, a palatial new club established since the War, under the presidency of "Sir Pope de Cambridge," who filled the office with distinction at the first conference. To quote *Le Soir*: "Chacun loue la clarté précise, la pondération, la pénétration et le tact parfait de sa présidence."

The members of the Scientific Committee present were: Mm. E. Briner (Geneva), O. Dony-Henault (Brussels), J. Duclaux (Paris), F. M. Jaeger (Groningen), A. Job (Paris), J. Perrin (Paris), F. Swarts (Ghent). In addition, the following attended by invitation: H. E. Armstrong (London), E. F. Armstrong (Warrington), G. Barger (Edinburgh), W. Barlow (London), A. Berthoud (Neuchatel), J. Boeseken (Delft), W. L. Bragg (Manchester), C. S. Gibson (London), Sir W. B. Hardy (Cambridge), T. M. Lowry (Cambridge), Ch. Maugin (Paris), Ch. Moureu (Paris), E. K. Rideal (Cambridge), H. Staudinger (Zurich), H. von Euler (Stockholm). The following professors in the University of Brussels were also present: G. Chavanne, J. Timmermans, H. Wuyts, E. Saerens, E. Herzen.

Twelve sittings were held, occupying six whole days, so the meeting was no mere joy-ride, the more as it took place under continental conditions of air and light and was a severe linguistic trial, English alternating with French in several tongues; indeed, even a little Swiss-German was introduced. That our self-sacrificing devotion was not unappreciated, is clear from a notice in *L'Indépendance Belge*: "Nous l'avons dit, les Conseils de Chimie, les conseils de Physique ne sont pas des congrès. Tout le temps dont disposent les savants qu'ils réunissent est consacré au travail. Généralement, on travaille encore au cours du déjeuner quotidien: la tâche n'est jamais interrompue."

The Council was received by His Majesty the King of the Belgians, at the Royal Palace, on the afternoon of Friday, April 17. Messrs. Heger and Lefebure, Sir William Pope, Sir William Hardy, and Profs. Armstrong, Jaeger, Moureu, and Perrin had the honour of dining with the King and Queen and members of the Royal family at the Palace at Laeken on the Saturday evening. On both occasions all were much impressed by the cordiality and sincerity of our reception and by the obvious appreciation the King showed of the service the Guild of Science is rendering. The meeting was the subject of serious notice in the press, and we learnt from lady friends, who made purchases in the city, that the conference was talked of even in *lingerie* circles. Such notice in Great Britain is unthinkable. These matters are ordered differently abroad. The courtesy shown to their visitors by M. Heger and his colleagues and by Madame Solvay and other members of her family cannot be adequately acknowledged.

The following reports were presented and considered: The Mechanism of Chemical Change, T. M. Lowry; Les Relations interatomiques médiates dans les composés organiques, F. Swarts; L'Adsorption en relation avec la catalyse et les actions enzymiques, J. Duclaux; Les Réactions intermédiaires dans la catalyse, Andre Job; Lumière et réactions chimique, Jean Perrin; On the Spreading of Fluids on Water and Solids and the Thickness of a Primary Film, W. B. Hardy; Structure des matières colloidales à l'état solide, M. J. Duclaux; The X-ray Analysis of Crystal Structure and its Bearing on Chemical Constitution, W. L. Bragg; Organic Crystals, W. H. Bragg; The Configuration of the Carbon Atom and the Geometrical Relations of this Configuration to those of other Atoms as evidenced in the Chemical and Crystallographic Structures of Organic Chemistry, W. Barlow; Recent Developments in the Theory of Catalytic Processes in Heterogeneous Reactions, E. K. Rideal; Catalysis at Solid Surfaces, E. F. Armstrong and T. P. Hilditch; Considérations sur l'autoxydation et les phénomènes catalytiques qui s'y rattachent, C. Moureu et C. Dufraisse; Catalysis and Oxidation, Henry E. Armstrong; General Views on Catalysis in Enzyme Reactions, H. v. Euler.

As to the outcome. The Conference was definitely an advance on the first. The subjects considered were more fundamental and of critical importance. It cannot be pretended, however, that the reports were adequately discussed. When published, probably at an early date, they will undoubtedly serve to stimulate a far more complete consideration of the issues raised. The discussions were not reported verbatim and will be known only in the form of brief summaries. Few of the reports were circulated in time and several were obviously insufficiently thought out. At the next Conference it should be made a condition that reports are all in the hands of those who are to participate in their discussion at least three, better six, months before the meeting. Instead of reproducing discussions, except in the briefest possible manner, to indicate who speaks and to what end, it may be better to allow each reporter to supplement his contribution and give a considered opinion, if not upon the proceedings as a whole, at least on the problems with which he is specially concerned. Remarks made almost casually at such meetings may be of profound significance.

M. Ernest Solvay undoubtedly did great service to science in endowing the foundation to which his name is now permanently attached. The organisation is destined to play an important part in the future development of physical science, by focussing attention, at suitable intervals, upon fundamental theoretical issues. There has been far too little serious discussion of this kind, and, as a consequence, chemistry, in particular, is encumbered with a mass of loose speculation by workers whose outlook is far too narrow for them to discuss with advantage the problems they affect to consider. We need to put an end to the present-day tendency, particularly obvious in chemical circles at the moment, to paraphrase in terms of new fashions, without in any way getting down to fact or making any real advance in treatment.

The great advantage of such international gatherings is that different mentalities are brought into contact and opportunity given to bring out the facts. The physical school to-day, unfortunately, has little regard for facts: its main office seems to be to distort them in the service of the fashion by which it is dominated. The most recently published text-books are witness of this tendency: a great volume of pseudo-mathematical sack is provided, but the bread of fact is scarce regarded, and there is not the faintest indication of the "proportionate judgment" being brought into play the use of which was so strongly insisted upon by Faraday—which he contended, moreover, should be the great outcome of devotion to scientific inquiry.

At the Conference, two main topics were under discussion—the nature of chemical change in its various forms, and molecular structure as revealed by X-ray and geometric analysis. No particular advance was made in dealing with the former, but the issues were presented probably more clearly and definitely than they have been hitherto: the view

of the French school was certainly broadened. The tendency is growing to recognise that the phenomena are of greater complexity than has been supposed, and even to hark back to Faraday's conceptions. It is an astounding fact and a great reproach to our science, that we are in no way agreed as to the precise mechanism underlying the simplest case of chemical change. We simply have no criteria. Unfortunately, we have wandered during forty years in the wilderness, wearing teutonic blinkers At the root of our difficulty is the lack of philosophical outlook, due to narrowness of practical experience, insufficient knowledge of materials and processes, and undue specialisation We need a Wagner to knit our scattered themes into rhythmic form. we need also to pay far more attention to fact.

The discussion of the structure of solids was probably the most important part of the proceedings A great difference of opinion between chemist and physicist was apparent The able account of the results of the X-ray analysis of crystals given by Prof Bragg was much appreciated. It is clear that it is possible to determine the orientation of atomic centres in crystals, but it is in no way proved that the partitioning of the atoms among the molecules can be ascertained. Prof Bragg was prepared to admit this The volume occupied or influenced by the atom was also much discussed Here again it was agreed that the X-ray method, at present, affords no direct information and that only the distance between atomic centres can be fixed. Precision was given to this latter problem by Mr. Barlow, who gave an account of the way in which he has modified the original Barlow-Pope valency-volume hypothesis, by using a cell of unit-valency and forming models of atoms of higher valency by associating such unit-cells in the appropriate numbers. Mr. Barlow has constructed close-packed models of a considerable number of benzene derivatives which are in direct near agreement with crystallographic data: several of these were exhibited. The writer was able to point out how closely the properties of carbon were reproduced in the model of the carbon atom—a pyramid of four unit-dodecahedral cells—used by Mr. Barlow in constructing his models. Finally, the existence of atoms in the crystal—in common salt, for example, —as independent units was brought under discussion. Mr. Barlow exhibited a model of the molecule of potassium chloride, composed of two similar 13-faced cells, such *molecular* units may be close-packed in any numbers to give crystal units having all the geometric properties shown by potassium chloride. The writer expressed the opinion that it was impossible, from the chemist's point of view, on present evidence, to believe for one moment that the molecule lost its individuality in the crystal. H E. A.

Heavy-Oil Engines.

THE James Forrest Lecture for 1925 was delivered by Capt. H. Riall Sankey before the Institution of Civil Engineers on May 5, and dealt with some outstanding questions relating to large engines of the self-ignition type. The discussion was limited to engines working either on the two- or the four-stroke cycle, and compressing air to a temperature sufficient for the self-ignition of an injected fuel of not less than 0 82 specific gravity.

There are many difficulties in connexion with fuel-injection, and much research is still required before practical perfection is reached and the best method finally established. The two methods employed are air-injection and mechanical injection (also called solid injection). The former requires an air-compressor, and introduces oxygen with the oil, producing probably a small initial explosion together with an air-blast which causes turbulence and drives the oil into all parts of the combustion chamber. The expansion of the air cools the jet by some 100° F., which has to be allowed for by a higher initial pressure of the air in the cylinder. The air injector is able to impart greater energy to the atomised oil, to which is probably due the fact that a greater indicated mean effective pressure is possible with air than with mechanical injection, as has been found by Engineer-Commander Hawkes. The cooling effect of air-injection is especially noticeable at light loads, and may cause misfires and explosion troubles; mechanical injection is much freer from these troubles. It would appear that at present the economical results per I.H.P. are better with air-injection than with mechanical.

High temperatures and pressures occurring in heavy-oil-engine cylinders cause stresses which are difficult to meet. The parts principally affected are the cylinder head, the cylinder walls, and the piston Cast steel is generally employed for the heads, since the same strength can be obtained with much thinner walls, and the temperature-stresses are thereby substantially reduced In large cylinders with thick walls the temperature-stresses in the walls exceed the ring-stress due to the internal pressure. Various ways of strengthening the walls have been employed and were mentioned by the lecturer. Some idea of the relative ring- and temperature-stresses may be obtained from the following figures given by Mr. A. D. Bruce for a 40-in. cylinder:

Thickness of Cylinder Wall.	Tension in lb per sq. inch due to	
	Ring Stress.	Temperature-Stress
2 in.	5000	10,630
3 5 in	2800	18,600

Temperature affects the design of pistons profoundly. Hopkinson has shown that a gas-engine piston 11 5 in. in diameter, without water or oil cooling, may have a temperature-stress of tension at the outside rim amounting to 7·5 tons per sq. inch. Hence, for larger diameters, cooling arrangements have to be adopted Such arrangements—except in experimental engines—have not been successfully applied to pistons exceeding 33 in. in diameter.

A large mean effective pressure is desirable to reduce the weight of and the space occupied by the engine, and can be obtained by increasing the weight of oil injected per stroke if arrangements are made for reasonably perfect combustion. This requires an increase of oxygen packed into the compression space, and is known as supercharging. The method has been successfully worked to obtain higher powers with aeroplanes at high altitudes. It has been estimated that about 50 per cent. more indicated power may be obtained by supercharging, but a deduction of about 10 per cent. must be made for the power required, leaving a net gain of 40 per cent. It cannot be said that supercharging has advanced very far at present, except in two-stroke engines, but it may be expected to produce great improvements in the future.

Among other matters dealt with by Capt. Riall

Sankey is the question of compounding. A group of American engineers, headed by Mr. Sperry (of gyroscope fame), has been working on this subject for thirty years. Complete success with a small engine was reported in 1918, but Capt. Riall Sankey stated that he was not aware whether any large engine has yet been made or is under construction. In the small engine the mean effective pressure in each cylinder was 330 lb. per sq. inch, and the weight of the engine was about 0.1 that of an ordinary engine The mechanical efficiency was said to be extremely high

Capt. Riall Sankey, in concluding his lecture, urged the necessity for co-operation in research, and offered his appreciation of the work done at the Admiralty Research Laboratory and so freely communicated in papers read before the Institution of Naval Architects. The outstanding problem for the merchant marine is the production of a low-speed engine of much greater power than at present possible, and of lighter weight per B.H.P., but before this can be solved the many subsidiary problems discussed in the lecture must be solved satisfactorily

Tertiary Floras.[1]

DR. BERRY continues to add to his vast series of researches into the Upper Cretaceous and Tertiary floras, a subject which has long been somewhat neglected in Great Britain The question of the evolution of angiosperms is almost the greatest outstanding problem of palæobotany We have practically no light upon it as yet; all that can be done is to record the history of the class as accurately as possible, and to this history Dr. Berry has long been the most indefatigable contributor

The present memoir deals with a Middle and an Upper Eocene flora of North America, the former known as the Claiborne, the latter as the Jackson flora. The author had previously described the much richer Lower Eocene Wilcox flora. The Wilcox includes 350 known species, while from the Claiborne only 90, and from the Jackson 133 are recorded. These differences appear to be due rather to the conditions of deposition than to any poverty of vegetation in the later periods

The Claiborne deposits extend at intervals from Georgia to south-western Texas, they are marine in origin, which helps to account for the scantiness of the remains. The plants include 1 fungus, 6 ferns, 5 conifers, 8 monocotyledons and 70 dicotyledons. The largest family is the Lauraceæ, of which 13 species are recorded, while the Leguminosæ are represented by 8 and the palms by 6 Some of the species (a cypress and two laurels) are represented in the form of petrified wood, of which sections are figured. The same is the case with some of the Jackson plants, including a beautiful specimen of palm-wood. Most of the commoner species occur also in the underlying Wilcox and the succeeding Jackson formations. Many of the genera had already appeared in the Upper Cretaceous Among the dicotyledons only three families out of 27 are gamopetalous Two of the gamopetalous genera (Diospyros and Apocynophyllum) go back to the Upper Cretaceous Dr. Berry thinks that the Gamopetaleæ were actually the last plants to appear, and that their wealth of species may only have been attained in post-glacial times The comparative poverty of this group in trees and shrubs may, however, account for their rarity as fossils.

The Jackson flora has a similar geographical distribution to that of the Claiborne beds The 133 species include 4 fungi, 1 liverwort (a Marchantites), 4 ferns, 1 Equisetum, 2 or 3 conifers, 15 monocotyledons, and 106 dicotyledons There are 8 palms, 12 Leguminosæ, and no less than 16 Lauraceæ. Among the Fagaceæ, it is interesting to learn that the genus Dryophyllum is regarded as an "ancestral" stock, which gave rise to Castanea, Quercus, and other genera. One of the leaf-species is referred to the Proteaceous genus Banksia, now limited to Australia. Among the lime family there is a Grewiopsis, an ancient Upper Cretaceous genus, and also a Tilia of quite modern type

These few notes can give little idea of the abundance of information in this extensive memoir It is splendidly illustrated; most of the 65 plates portray the fossil specimens, a few show views of the localities, restorations, or analogous contemporary vegetation. One of the restored landscapes introduces animal life in the form of a Zeuglodon, an early and, to all appearance, ferocious whale Dr. Berry is much to be congratulated on this fine memoir, his latest contribution to the subject to which his life has been devoted.

[1] The Middle and Upper Eocene Floras of South-eastern North America. By E. W. Berry. United States Geological Survey. Professional Paper No. 92. Pp. 206+65 plates. (Washington: Government Printing Office, 1924.)

The Royal Society Conversazione.

ON May 13 the first of the two annual conversaziones of the Royal Society was held in the Society's rooms, and numerous interesting exhibits and pieces of apparatus were arranged for inspection by fellows and guests of the Society.

Among the exhibits from the British Museum (Natural History) were some oceanic angler fishes shown by Mr. C. Tate Regan (Department of Zoology). These fishes inhabit the middle depths of the ocean about 500 to 1500 metres below the surface. The males have become dwarfed and parasitic on the females, to which they become attached probably soon after they are hatched, when they are relatively numerous.

The Geological Department showed deinosaur bones from Tendaguru, Tanganyika Territory, a selection from the material sent home by Mr. W. E. Cutler of the British Museum Tanganyika Expedition. The largest and smallest femora (4 ft. 1 in. and 2 ft. 6 in. long) belonged to sauropodous deinosaurs which inhabited the estuarine waters of a great river running from west to east. The other femur (3 ft. 4 in. long) was from one of the armoured and terrestrial deinosaurs, such as Omosaurus, which is found in the Jurassic of England.

The National Institute for Medical Research had a demonstration showing a colour reaction for vitamin A (Dr. O. Rosenheim and Dr. J. C. Drummond). A brilliant ultramarine-blue colour reaction is given when arsenic chloride is added to a substance containing vitamin A. The reaction has been adopted for the colorimetric determination of the growth-promoting activity of medicinal cod-liver oils and butter.

The Cambridge Instrument Co., Ltd., showed, among other things, experiments with the Shakespear katharometer applied to the thermal-conductivity method of gas analysis. The instrument has small

capacity, a small time lag, and is very sensitive to certain gases having thermal conductivities differing from one another It can be used for demonstrating the partial separation of two gases from a uniform mixture by introducing a temperature gradient within the gas, an effect first pointed out by Prof. S. Chapman and called by him "thermal diffusion"; for the measurement of the respiration of gas from a single insect, *e g* a fly; and provides an easy method of estimating a small quantity of carbon dioxide as carbonate in a mixture The National Physical Laboratory exhibits included some photo-electric cells of different alkali metals used to detect a difference of colour in sources of light (Mr T. H. Harrison). A rubidium and a sodium cell are connected in series, and the photo-electric currents balanced against each other when the two cells are exposed to the illumination of the same electric lamp If the temperature of the lamp is raised the sodium cell becomes relatively more sensitive and vice versa By this method lamps can be colour-matched to within 1° K of the equivalent temperature and within 0 1 per cent voltage The Research Department, Woolwich, showed an apparatus for determining the flash velocity and pressure factors of ignitory detonators; the former by passing the hot gases through gaps—at specified distances apart—in separate electrical circuits whereby the circuits are completed, the instants of completion being registered by means of an Einthoven galvanometer, and the latter by means of a piezo-electric crystal. Prof. W M. Thornton exhibited a miner's electric lamp which indicates and measures firedamp.

Mr. George H. Gabb showed a curious trumpet-shaped telescope bearing the name and date "Iacob Cvnigham 1661." The optical system is of the most elementary Galilean form, consisting of a bi-convex object glass, with a plano-convex eye lens, and gives a magnification of about 3 diameters at a focal length of 2 ft. It is focussed by two draw tubes covered with the characteristic marbled paper of the Charles II period.

Demonstrations were given during the evening of a cinematograph film by Pathé Frères showing Brownian motion. The film was taken by the aid of a high power microscope, and showed the translatory, and in some cases the rotational, movements of particles in colloidal silver, smoke, etc

Apparatus was also exhibited by the Thermal Syndicate, Ltd., the International Western Electric Co., and Messrs Adam Hilger, Ltd.

University and Educational Intelligence.

ABERDEEN.—The University Court proposes to proceed to the foundation of chairs in bacteriology and forestry

The plans of a new building to accommodate the Department of Forestry, and to be erected in the Cruickshank Botanic Gardens, have been approved.

BELFAST.—At a special meeting of the Senate of the Queen's University held on May 13, it was resolved to grant the degrees of D.Sc. (*honoris causa*) to Prof. F. G Donnan, professor of inorganic chemistry in University College, London, and to Prof. E. W. MacBride, professor of zoology in the Imperial College of Science, S. Kensington, both of whom are former students of Queen's College, Belfast

BIRMINGHAM.—The University has arranged to hold receptions at Edgbaston for the meetings of the following Societies: Institute of Electrical Engineers (June 10), Medico-Psychological Society (July 7), Iron and Steel Institute (September 10), Library Association (September 16).

CAMBRIDGE.—The Raymond Horton-Smith Prize has been awarded to Dr. M. B. R. Swann, Gonville and Caius College, for a thesis on "The Immediate Effect of X-Rays on the Functions of Certain Tissues and Organs." *Proxime accessit*, Dr. D. V. Pickering, Emmanuel College, whose thesis was on "Difficulties in the Dietetic Treatment of Diabetes."

It is proposed to confer the degree of Doctor of Laws, *honoris causa*, upon His Excellency the Right Honourable the Earl of Reading, Governor-General of India.

Prof Nuttall, Magdalene College, Dr H. Scott, Trinity College, and Mr W. A. F. Balfour-Browne, Gonville and Caius College, are to be the representatives of the University at the international congress of entomology to be held at Zurich in July.

LONDON.—The Report of the Principal Officer of the University for the year 1924–25, read on Presentation Day (May 13), records no important development of the scientific side of the University's work. Candidates for first and higher degrees have reached record totals of 3063 and 357, and a grand total of 3420, of whom 2079 were internal and 1341 external The roll of internal students comprises 9002 names, also a record The total admissions by all channels amounted to 7603, as compared with 3852 in the last year before the War Of these, 5542 came in through the ordinary Matriculation Examination, 360 as graduates of other universities, 1481 as holders of approved certificates, and 220 after examination under Statute 116. As there were 20,869 candidates for Matriculation and Registration, the high proportion of failures at the Matriculation Examination, which has recently provoked discussion, is evident. Grateful reference is made in the Report to the serious losses the University suffered in the deaths of Sir Sydney Russell-Wells, its representative in Parliament, Dr. R M. Walmsley, chairman of Convocation, and Prof Arthur Dendy Referring to the work of the Departmental Committee of the Board of Education, the Principal Officer says: "We may feel sure that the deliberations of the Committee, which has now been sitting for some months, will be guided by a single purpose, namely, our corporate welfare; and we may await with confidence its findings, not unmindful that in whatever form the body of our constitution be moulded, the spirit which gives life and growth remains always within ourselves alone." The list of benefactions received by the University during the year is somewhat meagre; but several of the colleges and medical schools have received generous gifts, notably the Middlesex Hospital Medical School, which has received 20,000*l.* from Mr. S. A. Courtauld for the endowment of a University chair of anatomy.

MAJOR K. W. BRAID, assistant in the Herbarium, Royal Botanic Gardens, Kew, since November 1923, has been appointed to the chair of agricultural botany in the West of Scotland Agricultural College, Glasgow.

NOTICE is given that applications for grants from the Chemical Society Research Fund must be made to the Assistant Secretary of the Society, Burlington House, Piccadilly, W.1, by June 1, on a special form to be supplied upon request.

APPLICATIONS for junior Beit Memorial Fellowships for Medical Research must be received not later than June 1, upon a prescribed form, by Sir James K. Fowler, Honorary Secretary, 35 Clarges Street, W.1. The fellowships are of the annual value of 350*l.* and tenable normally for 3 years.

Early Science at Oxford.

May 26, 1685. Mr. Pulleyn is desired to take ye Chair.

A Letter from Mr. Maunders, dated Dunstar-Castle April 24 1685, was communicated by Mr. Crouch. With it there came some of ye shells of the purple fish from the shore near Dunstar; the Fish it self would have been sent, but it will not bear carriage hither That matter, which gives the purple, is (as Mr. Maunders affirmes) a little wat'ry substance in ye back of the fish, and not enough to make above six or seven letters. With these shells (some of which are ordered to be preserved in the Musæum, others to be sent ye Royall and Dublin Societies) there came specimens of 2 sorts of Laver (or *Lichen Marinus*) growing on the same shore; the one green and large, the other blackish and lesse; this last sort is that, which is pickled and brought to table, the former is not used in those parts. There came also a little piece of Lignum Fossile from Watchet.

Another Letter from ye same Person, dated Milton-Abby (in Dorsetshire) May 16, 1685. was read; it gave an account of what number of Persons were killed by cold in Dorsetshire on ye dreadfull 23 of December last.

The Society ordered their thankes to Mr Maunders for these considerable communications.

A Letter from Mr Aston dated May 21, 1685 was read; it contained a draught of ye Hony-combes mentioned in the Minutes of ye Royall Society and lately sent ye Society by Monsieur Villermont.

An account of a New Callesh invented at Dublin (the advantage of which is, that it may overturn without any danger to any Person in it) was read.

May 27, 1684. A Letter from Mr. Aston, dated May 15th, was read, with an Extract out of 2 manuscripts (supposed to be writ at least 300 years agoe;) concerning *Ignis Græcus*.

On this occasion Mr. Bernard affirmed, that there is an account of *Ignis Græcus* in an Arabick manuscript, in St. John's College Library in this Univrsity, and in Julius Africanus's Cesti cap: 45. Mr. Piggot said he was told, by one that makes fireworkes, that Rockets made of Sulphur vive will burn under water. Dr. Plot shewed ye following Experiment: he held a live coal to ye lower part of an *hour-Glass* which immediatly stopped ye running of ye sand; this he repeated two, or three, times with ye like success.

Another Letter from Mr. Aston dated May 22, was read; it mentioned an Experiment of weighing air. Mr. Aston was desired by ye Society to give them an account of ye method usd in that Experiment.

A Paper of Mr. Flamsteeds was read, which gave an account of a *spot* which he had observed in ye *Sun*, about a month since.

The Answers of Mr. Proctor Clarke of Magdalen College and of Mr. King in Staffordshire, to some Queries about ye splitting of Trees in ye *frost*, were read. Dr. Plot said ye white grape vines in ye Physick Garden are dead, but not ye red, tho growing on ye same wall.

Mr. President observed, that severall vines which are split, are dead above ye place split.

Then Mr. Wal[illegible] produced a modell of ye *Roof* of a Church, which may be built 70 foot wide, without any pillars in it, and a paper was read by him to prove, that such a roof would be strong enough for use.

Mr. Cooke, a gentleman near Newberry, and Mr. Packer M.B. a physician of Reading were elected. Mr. Todd M.A., fellow of University College and Mr. Denbrigg M.A. of the same College were proposed for election into the Philosophical Society.

Societies and Academies.

LONDON.

Royal Society, May 14.—E. C C. **Baly** and Elizabeth **Semmens**: The selective photochemical action of polarised light. I. The hydrolysis of starch. Starch grains in weak enzyme solution are hydrolysed under the influence of polarised light, whilst very little or no action takes place in ordinary light of the same intensity. In the case of potato and maize starch diastase was used, whilst in the case of wheat starch the natural enzyme sufficed. The slides were placed on microscope stages and illuminated from below so that the progress of the hydrolysis could be watched. Both daylight and artificial light were used with equal success.—R B **Thomson** and H B **Sifton** Resin canals in the spruce (Picea) An anatomical and œcological study and its bearings on phylogeny. Anastomosis between different systems of resin-canals is rare in Picea. The bast has only horizontal canals, with bulbous expansions Horizontal canals are strictly confined to the *secondary* rays. The canals, except in the wood, show cambial growth in size and thickness of wall. Formation of canals is not dependent on increased vigour or food-supply, and in secondary tissues it is always connected with injury or irritation of the cambium The root, being very subject to injury, has a well-developed system of canals. In primary wood of the root the appearance of canals is preceded by that of solid strands of cellular tissue. Accumulation of repeated wound-stimuli explains the sporadic occurrence of canals in twigs of trees of species from which canals are otherwise absent. The whole evidence favours the hypothesis of a phylogenetic increase of sensitiveness to wound-stimuli among Coniferæ.—H. G. **Cannon**: On the segmental excretory organs of certain fresh-water ostracods The "shell gland" of the fresh-water ostracods, which has previously been described as the antennal gland, is of unknown function, but is in no way serially homologous with the true segmental excretory organs These occur in both antennal and maxillary segments The antennal gland (hitherto undescribed) consists of an end-sac with an intracellular duct leading to the exterior, consisting of three cells only It attains its maximum development in the fourth larval stage, after which it loses connexion with the exterior and degenerates. The maxillary gland consists of an end-sac with an efferent intracellular duct consisting of four cells only. Its end-sac is a true cœlomic sac. Its duct is formed by an ingrowth of ectodermal cells, that finally become overgrown by the surrounding ectoderm. The development of the "shell gland" has been partly described. The part previously considered as a typical end-sac, and therefore of mesodermal origin, arises from a group of ectodermal cells in outer layer of shell-fold.—E. G. T **Liddell** and J. F. **Fulton**: Observations on ipsilateral contraction and "inhibitory" rhythm. Simultaneous mechanical and electrical records have been obtained (with string galvanometer and torsion-wire myograph of high frequency) of responses of quadriceps extensor muscle (cat) to various forms of reflex stimulation, before and shortly after section of the posterior root supply of the muscle. When the normal muscle is reflexly stimulated at 50 per sec. through the sciatic nerve of the same side, a small rapidly developed contraction ("ipsilateral") results, in which the rhythm of stimulus may be seen in both string and myograph. Crossed stimulation at 15 to 20 sec before cutting the posterior roots also produces a response, but later, the rhythm tends to be obliterated through the

appearance of increasingly large numbers of "secondary" waves. *After* cutting, the secondary waves are more numerous from the start. Increase in mechanical tension increases amplitude of both primary and secondary waves A single moderately strong break-shock inhibition, during a crossed extension response causes, through suppression of secondary waves (repetitive asynchronous after-discharge), an enhancement of primary excitatory rhythm in both string and myograph. Repetitive inhibition, if weak, produces the same effect, if strong, it gives rise to a rhythm of its own rate in both records This "inhibitory" rhythm during "complete" inhibition seems to be due to the small uninhibitable increment of ipsilateral contraction.—K. **Furusawa**: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Pt X The oxygen intake during exercise while breathing mixtures rich in oxygen As was shown before, the maximum oxygen intake may be increased 50 per cent by the breathing of a mixture rich in oxygen This can be attributed only to an increased circulation rate of the blood.—J S **Yeates**: The nucleolus of *Tmesipteris Tannensis* Bernh. In Tmesipteris the maximum number of nucleoli in resting cells of the sporophyte is six. These are formed at telophase by aggregation of small bodies and are often visibly continuous with telophase chromosomes. In sister-telophase nuclei they frequently correspond in number, in size, and in position During prophase and metaphase the nucleoli are connected with the ends of chromosomes, from which they finally become detached and pass irregularly towards the poles of the spindle In some cases the full number of these nucleoli remains visible in the cytoplasm when a new generation of nucleoli has arisen in the daughter nuclei. In resting cells of the gametophyte the maximum number of nucleoli is three. The nucleolus is not an independent, self-perpetuating body, but seems to owe its origin to the chromosomes, and arises *de novo* in each cell-generation.

Physical Society, March 27.—H. W. **Gilbert** and P. E. **Shaw**: The electrical conditions arising at a liquid-gas interface Many of the results may be explained in terms of the modern theory of orientation and polarisation at the liquid-gas interface, but there are other facts which do not appear to come within the scope of any established principles.—L. **Hartshorn**: A contact theory of dielectric absorption and power losses. A simple explanation is proposed of absorption residual charge and allied phenomena in solid dielectrics In accordance with classical theory, the dielectric is assumed to possess a certain true capacity, defined by its dielectric constant, and a certain conductance, here considered as probably electrolytic in type. The so-called anomalous properties are considered to be due to the properties of the contact surfaces of the dielectric and its metal electrodes. These contact surfaces appear to offer great resistance to the passage of ions or electrons across them, so that when an E.M.F. is applied to a condenser there is an accumulation of charges at the surfaces. These charges form the absorbed and residual charges. The behaviour of each contact surface is such that it may be represented by a large capacity in parallel with a high resistance, and thus a capacity-resistance combination is suggested, which is equivalent to an actual condenser.

Linnean Society, April 2.—W. R. B. **Oliver**: Biogeographical relations of the New Zealand region. From a biological view-point the outstanding characteristics of the fauna and flora of the New Zealand region are the absence of mammals, the marked dissimilarity of its plant and animal productions to those of Australia, and the presence of an element common to two or more of the southern land-masses. A large proportion of the plants and animals at present living in New Zealand are such as require continuous land connexion for their dispersal. Their presence demands that at some period in the past New Zealand was joined to the other land-mass of the globe. Most of these animals and plants are related to species now found in lands to the north. The so-called "Antarctic" element appears to be a mixture of several elements. Eliminating the genera and species of plants common to New Zealand and South America which may be explained by migration from the north overland and from the west overseas, there remains a residue which seems to demand a more direct land route between New Zealand and South America.—W. C. F. **Newton**: The cytology of the genus Tulipa. The basic number of chromosomes is twelve, but as a result of fragmentation one species has sixteen. Alteration in the relative size of the chromosomes may occur independently of fragmentation. Tetraploid and hexaploid varieties and species occur. The different kinds of tetrad found in Tulipeæ have their exact parallels in the Acrididæ, thus helping to emphasise the essential similarity of the meiotic phase in plants and animals.

PARIS

Academy of Sciences, April 13.—G. **Ferrie** and R. **Jouast**: The use of photo-electric cells for the observation and maintenance of astronomical pendulums. A mirror is attached to the pendulum and light from this falls on a photo-electric cell: the resulting current is amplified by three or four valves. Measurements are being taken to compare, with the highest possible precision, the results obtained by this method with that given by the ordinary electrical contact.—Jules **Andrade**: The general mechanism of synchronisation.—Gaston **Julia**: A type of quasi-analytical functions.—Oscar **Zariski**: The development of an algebroid function in a domain containing several critical points.—S Ch **Bochner**: The nearly periodic functions of Bohr.—Comas **Sola**: The Schain comet (1925a) found independently. A photograph taken on the night of March 23 has shown the new comet found on the preceding night by Schain.—Charles **Nordmann** and C. Le **Morvan**: The ballistic theory and stars with continuous variation. Some deductions from the ballistic hypothesis of La Rosa.—Louis **Damblanc**: An apparatus applicable to aviation motors for reducing the loss of power with altitude.—Jean **Dubief**: The variation of the viscosity of fluids as a function of the volume. The relation between the viscosity of a gas μ, at a fixed temperature, compressed to a volume v is equal to that of a perfect gas multiplied by the factor $v/(v-b)$, where b is the co-volume of Van der Waals. The results calculated from this formula are in good agreement with the experimental figures of Philippa.—Jean **Thibaud**: The quantity of heat given off, in the form of the γ radiation, during radioactive disintegration. The energy emitted in the form of the γ radiation is never negligible: for radium B + C, it amounts to 16 per cent. of the total calorific effect.—Louis Jacques **Simon**: The viscosimetric neutralisation of the monoacids by alkalies. Comparison of the alkaline chlorate, bromate and nitrate. Measurements of viscosity in aqueous solution enable the course of the neutralisation of the acids to be closely followed. No relation between viscosity and isomorphism could be made out.—**Volmar**: The photolysis of the dibasic acids. In the cases of oxalic, malonic, succinic, and glutaric acids there was agree-

ment between the experimental facts and the law of photochemical equivalence.—P. **Bugnon**: Leaf homologies in the sweet violet: stamens and carpels. In the violet the stamens are homologous with the petals.—O. **Munerati**: Variations in the composition of the juice of a beetroot according to the state of disintegration of the tissue and the methods of expression. Two variables are studied, the state of disintegration before applying pressure, and the magnitude of the pressure applied. The variations observed are expressed in terms of the percentage of sugar in the expressed juice.—H. **Lagatu** and L. **Maume**: The linear relation between the successive quantities of phosphoric acid and nitrogen contained in the leaf of the well-nourished vine.—Émile F. **Terroine** and Mlle. S. **Trautmann** and R **Bonnet**: The quantitative bio-energy law of the formation of carbohydrates at the expense of proteids and fats in plants. The transformation of proteids into carbohydrates in plants is accompanied by a loss of 35 per cent. of the metabolised energy; with fats there is a loss of 23 per cent.—E. **Aubel** and J. **Salabartan**: The mechanism of the production of hydrogen at the expense of glucose by the coli bacillus. Evidence is given in support of the view that the glucose is converted into equal molecules of pyruvic acid and hydrogen.—H. **Labbé** and F. **Lavagna**: The chemical composition of the normal and pathological crystalline lens. Determinations of water and various forms of combined nitrogen in a normal lens and one with cataract. In cataract there is a modification of the normal proteid content, a sensible disintegration of the albumen, and a large increase in the proportion of aminoacids and in the products of incomplete hydrolysis of the albumens. These characters point to the intense proteolysis which accompanies the evolution of cataracts.—C. **Levaditi**, S. **Nicolau**, and P **Poincloux** The etiological rôle of *Streptobacillus moniliformis* in acute septicæmic polymorphic erythema.

Calcutta.

Asiatic Society of Bengal, March 4.—H. **Bruce Hannah**: Indian origins. The Pāncha-Janāh mentioned in the Rig-Veda were probably four concrete communities of Western Asia who had belonged to the invading forces defeated in Syria *c.* 1156 B.C., by Rāmēsēs III., and had afterwards plunged off eastwards, plus a *drūj*-folk picked up in or near Gāndhāraland. The Dasyūs of Sapta-Sindhavāh were diffused representatives, east of the Indus, of the ancient and widespread Dahyūs of Central Asia.—Sri Ram **Sharma**: A forgotten hero of Marwar.—D. **Majumder**: Physical characteristics of the Hos of Kolhan. Anthropometric measurements of 200 Hos of different septs and localities are given.—Satyendra **Ray**: The earth's electric field and vertical potential gradient. The potential of the earth's electric field falls much more rapidly with height than would be expected with a radial field. The curve showing the variation of the potential gradient with height, as given by Schweidler and Kohlrausch, suggests an exponential curve. From theoretical considerations a formula is obtained which fits the curve and explains simultaneously the variation of the potential with pressure and the atmospheric "pollution."

Washington, D.C.

National Academy of Sciences (Proc. Vol 11, No. 2, February).—E. H. **Hall**: Conditions of electric equilibrium at boundary surfaces: Volta effect. A theoretical development based on the theory of "free" and "associated" electrons in metals.—A. H. **Compton** and J. A. **Bearden**: The effect of a surrounding box on the spectrum of scattered X-rays. A water-cooled molybdenum target X-ray tube and sulphur secondary radiator with no surrounding box were set up outside a window and the spectrum photographed. Modified lines were found in the position indicated by Compton's theory.—R. A. **Millikan** and I. S **Bowen**: The significance of the discovery of X-ray laws in the field of optics. Work on the spectra of stripped atoms of phosphorus (P V.), sulphur (S VI), and chlorine (Cl VII) has completed the proof that Moseley's law and its corollary, the irregular doublet law, holds in optics. To account for the regular or relativity doublet law in optics requires a new hypothesis. The doublets of atomic hydrogen and ionised helium are attributed to a true relativity cause, but those of lithium and all heavier elements to a non-relativistic cause, perhaps of magnetic or electrostatic and magnetic origin, giving similar results.—Y. H **Woo** The Compton effect and tertiary X-radiation The water-cooled molybdenum target X-ray tube was enclosed in a box lined with $\frac{1}{16}$ in. lead sheet, and rock-salt, magnesium, aluminium, silicon, and sulphur were used as secondary radiators. Shifted lines were found in accordance with the predictions of Compton's theory, but there was no evidence of the tertiary radiation observed by Clark, Duane, and Stifler.—E **Condon**: The age of the stars. The relativistic relation between energy and mass leads to a means, independent of atomic processes, of estimating the age of the stars.—W. J **Luyten**: Notes on stellar statistics III. On the calculation of a mean absolute magnitude from apparent magnitudes, angular proper motions, and linear radial velocities.—E. B. **Wilson** and W. J. **Luyten** (1) The frequency distribution on apparent magnitude of the non-Magellanic O-type stars Among the O-type stars there is probably a fairly large dispersion in intrinsic brightness and a fairly large scattering through space. (2) The population of New York city and its environs The ultimate population of New York city and its environs predicted by means of the Pearl-Reed curve would be 35 millions Applying the same method to the population of the States including this area gives only about 22 millions. Hence one or both of the populations will probably soon enter upon a new cycle of growth. The Pearl-Reed method predicts "saturation" with a population but does not allow for the condition of additivity. It can give more probable results if modified constants are used.—J. W. **Alexander** On the intersection invariants of a manifold.—P. **Franklin**: The rotating disc. Einstein's qualitative discussion indicates that the geometry on the disc cannot remain Euclidean, quantitative discussions by Lorentz and Eddington start from equations of transformation corresponding to a Euclidean rotation and end by computing contraction. An attempt is made at reconciling these opposed points of view.—G A. **Miller**: Transitive groups involving direct products of lower degree.—A. C. **Redfield** and A. L. **Hurd**. The respiratory functions of the hæmocyanins. The blue colour of the blood of the squid and horse-shoe crab is due to "oxhyæmocyanin," but the hæmocyanin of the crab has much greater affinity for oxygen. This affinity is increased by carbon dioxide, whereas in the squid it is decreased, a fact which seems related to the mode of life.—T. M. **Carpenter**. Prolonged fasting as affecting the composition of steers' urine.—P. **Heymans** and W. J. **Heymans**: The torsion problem of curved beams.—E. M. **East** and A. J. **Mangelsdorf**: A new interpretation of the heredity behaviour of self-sterile plants. Self-sterility in Nicotiana is a Mendelian recessive in crosses between self-fertile and self-sterile species. Members of a self-sterility group are cross-fertile with members of other similar groups, but the class of the mother is never represented in the progeny.

Official Publications Received.

Department of the Interior: United States Geological Survey. Forty-fifth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1924. Pp. ii+83+1 plate. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 750-G: Bauxite in Northeastern Mississippi. By Ernest F. Burchard. Pp. ii+101-148. Bulletin 751-D: Geologic Structure of San Juan Canyon and Adjacent Country, Utah. By Hugh D. Miser. Pp. iv+115-155+plates 15-20. Bulletin 751-F: The Ekalaka Lignite Field, Southeastern Montana. By Clyde Max Bauer. Pp. iv+231-267+plates 30-34. Bulletin 751-G: Geology and Oil and Gas Prospects of part of Moffat County, Colorado, and Southern Sweetwater County, Wyoming. By Julian D. Sears. Pp. v+269-319+plates 35-37. 20 cents. Bulletin 753: Geology and Oil Resources of a part of Los Angeles and Ventura Counties, California. By William S. W. Kew. Pp. viii+202+17 plates. 50 cents. Bulletin 760-B: The Physical Features of Central Massachusetts. By William C. Alden. Pp. v+13-105+plates 6-22. Bulletin 761: Molybdenum Deposits; a short Review. By Frank L. Hess. Pp. iv+35+10 plates. 15 cents. Bulletin 762. Geology and Ore Deposits of the Rochester District, Nevada. By Adolph Knopf. Pp. ix+78+4 plates. 15 cents. Bulletin 765: Geology of the Region around Lead, South Dakota, and its Bearing on the Homestake Ore Body. By Sidney Paige. Pp. iv+58+11 plates. 20 cents. (Washington: Government Printing Office.)

Department of the Interior, United States Geological Survey. Professional Paper 134. Upper Cretaceous and Tertiary Formations of the Western Part of the San Juan Basin, Colorado, and New Mexico, by John B. Reeside, Jr., and Flora of the Animas Formation, by F. H. Knowlton. Pp. iv+117+19 plates. 40 cents. Professional Paper 135: The Composition of the River and Lake Waters of the United States. By Frank Wigglesworth Clarke. Pp. iv+199. 50 cents. (Washington: Government Printing Office.)

Publications of the United States Naval Observatory. Second Series, Vol. 10, Part 2, Appendix. Total Solar Eclipses of August 30, 1905, and June 8, 1918, with Aviators' Notes on the Total Solar Eclipse of September 10, 1923. Pp. iii+B416+50 plates. (Washington: Government Printing Office.)

Review of Agricultural Operations in India, 1923-24. Pp. vii+152+8 plates. (Calcutta: *Government of India Press*.) 1.9 rupees, 2*s*. 9*d*.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 5: The Buffer Action of some Burma Soils. By J. Charlton. Pp. iii+101-121. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1*s*.

Report of the Kodaikanal Observatory for the Year 1924. Pp. ii+4. (Madras: Government Press.) 6 annas.

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands: Report on Experiments with varieties of Sugar-Cane conducted in Antigua, St. Kitts-Nevis and Montserrat in the Season 1922-23. Pp. ii+54. (Barbados.) 1*s*.

The Indian Forest Records. Chemical Series, Vol. 11, Part 5: The Constituents of some Indian Essential Oils. Part 16. Note on the Rate of Oxidation of *d*-Δ^3 Carene and other Terpenes in the presence of Catalysts. By Madyar Gopal Rao. Pp. ii+10+7 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1*s*. 3*d*.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1923-24. Pp. iv+35. (Barbados.) 6*d*.

Records of the Survey of India. Vol. 18 (Supplementary to General Report 1921-22): Annual Reports of Parties and Offices, 1921-22. Prepared under the Direction of Col. C. H. D. Ryder. Pp. iv+132+10 maps. (Dehra Dun: Trigonometrical Survey.) 4 rupees; 8*s*.

Proceedings of the United States National Museum. Vol. 65, Art. 9: A Revision of the West Indian Coleoptera of the family Buprestidæ. By Warren S. Fisher. (No. 2522.) Pp. 207. (Washington: Government Printing Office.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 36, Part 1, 1925. Pp. 106+11 plates. (London: Edward Stanford, Ltd.) 5*s*.

Smithsonian Institution. United States National Museum. Contributions from the United States National Herbarium. Vol. 23, Part 4: Trees and Shrubs of Mexico (Passifloraceæ—Scrophulariaceæ). By Paul C. Standley. Pp. 849-1512+xxxix. (Washington: Government Printing Office.) 60 cents.

Diary of Societies.

SATURDAY, MAY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (I.).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr. D. Forbes: The Climate of Brighton.

MONDAY, MAY 25.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr. D. Forbes: The Climate of Brighton.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—C. W. Wardlaw: Size in Relation to Internal Morphology. No. 2. The Vascular System of Selaginella.—J. Thomson: The Parasitism of *Cuscuta reflexa*, Roxb.—S. Williams: Some Points in the "Anatomy of Dicksonia."—Dr. A. E. Trueman and Miss Williams: Studies in Ammonites of the Family Schlœnbachiatidæ.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons of England), at 5.30.—E. W. Fish: Circulation of Lymph in the Dentine (Preliminary Report).

SOCIETY OF GLASS TECHNOLOGY (at Royal Society of Arts), at 7.30.—Prof. W. E. S. Turner: The Nature and Constitution of Glass.—Prof. G. Tammann: On Glasses as Supercooled Liquids.—Dr. F. Eckert: Some Remarks on the Constitution of Glass.—Dr. A. Q. Tool and E. E. Hill: On the Constitution and Density of Glass.—Prof. H. Le Chatelier: On the Viscosity and Allotropy of Glass.

ROYAL GEOGRAPHICAL SOCIETY (at Mollan Hall), at 8.30.—Col. C. H. D. Ryder: The Demarcation of the Turco-Persian Boundary in 1914.

TUESDAY, MAY 26.

SOCIETY OF GLASS TECHNOLOGY (at University College), at 8.30.—Sir W. H. Bragg: The Structure of Quartz and Silica.—V. H. Stott: The Viscosity of Glass.—Dr. G. W. Morey and Dr. N. L. Bowen: The Melting Relations of the Soda-Lime-Silica Glasses.—Dr. A. A. Lebedeff: Polymorphic Transformations in Glass.—Dr. G. W. Morey and Dr. R. W. G. Wyckoff: X-ray Studies of Soda-Lime-Silica Glasses.

ROYAL DUBLIN SOCIETY, at 4.15.

LINNEAN SOCIETY OF LONDON, at 5.—Anniversary Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington: The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (II.).

ROYAL SOCIETY OF MEDICINE, at 5.30.—Annual General Meeting.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at Art Workers' Guild, 6 Queen Square, W.C.1), at 6.—Annual General Meeting and Exhibition of Cartoons and Photographs of Stained Glass.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—H. C. Brewer: The Pattern of the Picture.

ROYAL ANTHROPOLOGICAL INSTITUTE (jointly with Eugenics Education Society) (at Royal Anthropological Institute), at 8.30.—Dr. H. F. B. Walker and others: Discussion on Miscegenation in South Africa.

WEDNESDAY, MAY 27.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Alfred Mond, Bart.: The Unemployment Problem.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section) (Annual General Meeting), at 5.—Dr. J. H. Sequeira: Parasitic Affections of the Skin communicated from Animals to Man.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—Dr. J. A. Murray: Lecture Demonstration on The Making of Microscopical Preparations. III. Staining.—The Microscope in Soil Microbiology.—G. Thornton: Soil Bacteria; D. W. Cutler: Soil Protozoa, Mrs. B. M. Roach: Soil Algæ.—Dr. W. B. Brierley: The Microscope and Plant Pathology.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—L. S. Penrose: The Relation of the Pleasure-Pain Principle of Freud to the Question of Growth.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—R. J. Ludford: (*a*) Cell Organs during Secretion in the Epididymis; (*b*) Nuclear Activity in Tissue Cultures.—J. Needham and Dorothy Needham: The Hydrogen Ion Concentration and the Oxidation Reduction Potential of the Cell Interior.—A Micro-injection Study.—Dr. F. W. H. Brambell: The Oogenesis of the Fowl (*Gallus Bankiva*).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O. Bower: The Natural Classification of Ferns as a Study in Evolution (II.).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 5.30.—Dr. J. Brownlee: The Health of London in the Eighteenth Century.

FRIDAY, MAY 29.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—Prof. F. G. Donnan: Principles governing Passage through Membranes.—W. Stiles: Problems of Permeability in Plant Cells.—J. A. Hewitt: Absorption from the Intestine.—L. J. Harris: Acidimetry, Ampholytes, and Proteins, followed by a discussion by Prof. A. V. Hill, Prof. S. B. Schryver, Prof. W. Ramsden, and others.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 2.—H. Munro Fox: On Chlorocruorin.—E. Stedman: The Oxygen Dissociation Curve of Hæmocyanin.—Dr. L. Hogben: Relation of Electrolytes to Invertebrate Muscle.—H. W. Harvey: Some Variable Properties of Sea-water.—W. E. Garner: Molecular Orientation in relation to Muscle Contraction and Nervous Conduction.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Industry Club), at 8.15.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Henry Newbolt: Scenery in the Pastoral Poets.

SATURDAY, MAY 30.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—R. Chambers and P. Rasnikoff: Studies on the Plasma Membrane and Physical State of Protoplasm by Micro-dissection and Micro-injection.—C. Shearer: Child's Hypothesis.—J. S. Huxley: Some Problems of Differential Growth.—Dr. W. H. Pearsall: Rates of Growth and Plant Form.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (II.).

FREE PUBLIC LECTURES.

MONDAY, MAY 25.

IMPERIAL COLLEGE OF SCIENCE—ROYAL SCHOOL OF MINES, at 5.15.—Prof. F. A. F. C. Went: Modern Conceptions of Light Stimuli in Plants.

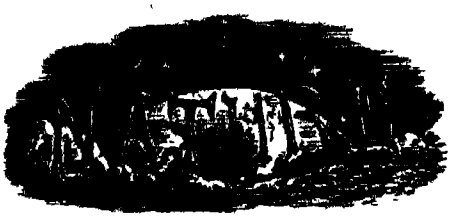
ROYAL SOCIETY OF MEDICINE, at 5.15.—Prof. E. Brumpt: How to conduct an Anti-Malarial Campaign (Chadwick Lecture).

THURSDAY, MAY 28.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Dr. W. E. Gye: The Filterable Viruses.

FRIDAY, MAY 29.

ROYAL SOCIETY OF ARTS, at 5.15.—Prof. E. Brumpt: The Prophylaxis of Sleeping Sickness (Chadwick Lecture).



SATURDAY, MAY 30, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2900, VOL. 115]

University Grants in Great Britain.

THE University Grants Committee, appointed in 1919 "to inquire into the financial needs of university education in the United Kingdom and to advise the government as to the application of any grants that may be made by parliament towards meeting them," has grown into a position of authority and influence greater than its terms of reference seem, at first sight, to imply. In pursuing its inquiries year by year, not only does the Committee obtain a completer knowledge of the conditions of university work at a given moment, but it also acquires an ever deeper insight into the dynamics of university economy. Inevitably, and to the great advantage of the universities, attention is concentrated less on the problem how to "carry on" and more on the trends of existing activities, their fitness for the purposes they are supposed to serve, and the values of those purposes. While the Committee is careful to disclaim the wish to impose, or, indeed, the ability to propound, an ideal common policy, it cannot escape the necessity of attempting to evaluate conflicting university ideals Each year since 1920 it has published statistical returns submitted by the universities and university colleges in receipt of Treasury Grant, and has prefaced the returns with introductory notes. This year the returns (for 1923-24) are published as an appendix to a comprehensive report,[1] forming a sequel to the Committee's first report dated February 3, 1921.

The present report surveys the whole field of university education in Great Britain in the light not only of the statistical returns, but also of observations made in the course of a series of visits of inspection carried out by the Committee in 1924 with the object of seeing what progress had been made since the similar visitation of 1920. The Committee found that these four years have been years of real progress in regard to conditions of service of university staffs, the standards of teaching and research, the provision of adequate buildings and equipment, and the development of the social life of the students. Further improvement under all these heads is, however, urgently called for, and it is therefore a matter of urgent necessity that the universities and colleges should do all in their power to raise additional funds from local public bodies, industries, and private benefactors. In order to stimulate such efforts, the Committee announces that in distributing any additional money that may be voted it will continue to take serious account, wherever that can fairly be done, of the extent to which local support has been forthcoming, without, however, being bound to any

[1] University Grants Committee. Report, including Returns from Universities and University Colleges in Receipt of Treasury Grant, Academic Year 1923-1924 Pp. 44. (London: H.M. Stationery Office, 1925.) 3s. 6d. net.

precise formula. It concludes with an exhortation to regard endowment funds as the central source of revenue, as only by the consolidation of a stable and substantial income from independent sources can the autonomy and progressive development of a university be assured.

Although there are now 57 per cent. more full-time students at British universities and colleges than before the War, their number is still comparatively small. The President of the Board of Education has lately directed attention to the fact that as yet less than 4½ per cent. of all the children in grant-aided secondary schools go on to a university, and less than 9 per cent. of elementary school children go on to secondary schools. Both of these proportions are likely to increase. The Committee points out that the increase in the flow of students from the secondary schools to the universities will inevitably tend to heighten the importance of close co-operation between the university and school authorities upon questions of curriculum and teaching method, and, it may be added, the importance of the methods of admission. At present it seems impossible for the schools to satisfy the university teachers, because these cherish two apparently conflicting ideals On one hand, they decry "premature" specialisation in the schools and say they prefer students to come up to the university with a good foundation of general education. On the other, they want the schools "to relieve them of some of the less advanced work which they consider is now unduly taxing their time and energies, to the detriment of the higher studies which are the university teachers' proper business"

In the United States of America, where co-operation has been so close that admission has been largely by certificate of the completion of so many hours of high school work, there is urgent need, says the President of the Carnegie Foundation for the Advancement of Teaching, for the recasting of the existing entrance requirements so as to prevent the wholesale admission of the unfit and the consequent lowering of the plane of intellectual life The Committee states explicitly that it does not think that in Great Britain there is any immediate danger of such evils, but adds that it may be well to remember, as we develop our plans, that there will be constant need for a clear conception of the true functions of university education. The Committee proceeds to indicate its own views on the question of these functions with reference to certain practical questions.

For careers in the higher branches of commercial and industrial business administration, as for the upper administrative divisions of the civil service, a university training is valuable, in the opinion of the Committee, rather for the alertness of mind and capacity for taking broad views which it fosters than for specialised knowledge of the details of business. Dealing with the subject of the growth of specialisation, it notes with approval the policy of broadening the basis of the studies in all faculties, of breaking down the rigid barriers that specialisation tends to erect between subjects, and of insisting on giving students a clear sight of the wood as well as of the trees. The old antagonism of science and the humanities is giving place to a recognition of the fact that their proper relationship is one of active friendship, manifested, not by giving science students a smattering of the humanities, and vice versa, but by "the teaching of science and the humanities in such a way as to reveal their relationship to one another and their respective places in the wide world of human knowledge and endeavour" It would be difficult to find a more apt formula for expressing the philosophic point of view which should characterise the work of institutions of university standing.

From a consideration of the prospects of increased demands for university education, the Committee passes to the question of supply. The paragraphs which deal with this question will be read with dismay by those, if there be any, who have been looking to the Committee for encouragement of schemes for establishing new universities or colleges. First and above all, says the report, universities stand for quality, and although the capacity of organisations the essence of which is spiritual cannot be satisfactorily measured by money standards, the progress of university work under modern conditions is largely controlled by material factors.

For some years ahead, all the material support that can be expected from the State, from local authorities, and from private benefactors will be barely enough to keep British universities in a state of efficiency and provide for their expansion on a reasonable scale; nor are there sufficient grounds for believing that, given such expansion, they will not be able to meet all the needs likely to arise at much less cost than would be incurred in creating new universities or raising to the university level institutions which are now below it. In this connexion the Committee specifies 150,000*l.* a year as the minimum income for maintaining a university of the modern civic type with moderate-sized faculties of arts, pure science, medicine, and technology at the level of efficiency demanded by the requirements of the present day. It is perhaps in meeting with a steadfast and uncompromising "No" proposals with the objects of which the Committee is fully in sympathy, but which imperil the integrity of university standards, that the

Committee performs its greatest, if most disagreeable, service to the community.

Discussing the application of the policy of respecting the autonomy of the universities and, accordingly, recommending block grants in aid of general income rather than grants for specific purposes or to particular departments, the Committee makes some trenchant criticisms of the system under which the University of London is not in any real sense master in its own house · "Nowhere does the familiar problem of overlapping and duplication need to be more carefully and constantly watched than in London University, with its multiplicity of teaching institutions, and nowhere is the central machinery for dealing with it so inadequate" Perhaps the Departmental Committee now sitting will provide a solution of this problem.

Residential halls now accommodate only about 14 per cent. of the total number of full-time students of universities and colleges in Great Britain outside Oxford and Cambridge, and there is a strong demand for additional accommodation. Of the various types now in existence, the Committee favours that which approximates most nearly to the colleges of the older universities, providing not only board and lodging, but also a library and such amenities as gardens and tennis-courts, including among its residents some of the unmarried members of the university staff, and being under the supervision of a Warden of good academic standing. It specifies in some detail what experience suggests as the most important elements in halls of this type

In the equipment of faculties of technology some institutions have endeavoured to provide full-scale apparatus, and thus to save their students from having to get experience and training in outside workshops and factories. The Committee discountenances such attempts, and holds that a selection of up-to-date plant sufficient for a thorough training in technological principles is all that a good university teacher needs.

The present needs and problems of universities in respect of these and many other matters, such as the status of university teachers, libraries, appointments boards, post-graduation scholarships, and adult education, are dealt with in the twenty-seven pithy and readable pages of this report in a way which gives it great value, not only for the institutions directly concerned, but also for universities in all parts of the Empire. It is an authoritative statement of the present position and prospects of the universities of the British Isles, and as such it should receive the earnest consideration of all who are in any way concerned with university or other higher education.

Mendeliana.

(1) *Carl Correns Gesammelte Abhandlungen zur Vererbungswissenschaft aus periodischen Schriften*, 1899–1924 Pp ix + 1299 + 4 Tafeln (Berlin: Julius Springer, 1924) 96 gold marks

(2) *Gregor Johann Mendel: Leben, Werk und Wirkung.* Von Hugo Iltis. Pp. viii + 426 + 12 Tafeln (Berlin: Julius Springer, 1924) 3·60 dollars

(1) IN honour of Prof. Correns's sixtieth birthday, the German Society for the Study of Heredity has reprinted most of his papers relating to genetical subjects They compose a very substantial volume of 1300 pages. The subjects of this prolific labour have been numerous, but after his large work on cross-breeding the varieties of Maize, Correns has mainly been occupied with two of the most intricate problems of botanical genetics, the transmission of variegation and the determination of sex in plants. Regarding the first of these phenomena, owing to the vast diversity in the physiological nature of the several kinds of chlorophyll defect, general expressions are obviously unattainable. Variation, in fact, is a symptom. Everything depends on diagnosis, which though sometimes easy is commonly difficult and evasive Through contemporary work, especially that of Correns, those who come after will at least find the facts set out ready to be disentangled.

The problem of sex-determination in plants is still more complex, and no simple and generally acceptable solution is yet in sight. The tendency of modern opinion is in favour of the view which Correns himself has advocated, that in dioecious plants the male is the heterogametic sex, but this interpretation is not wholly free from objection In plants, as also to some extent in animals, an outstanding difficulty is the complete absence of any satisfactory account of the relationship of the hermaphrodites to the sexual forms. Correns was the first to observe the remarkable fact that in gynodioecious plants the offspring of females are generally in a large majority females, those of the hermaphrodites consisting predominantly, sometimes entirely, of hermaphrodites. This is now recognised as being only a special case of a system of inheritance governing that of a great variety of characters. The essential phenomenon is genetical inequality between the eggs and pollen-grains of the same plant, of which many examples are now familiar, the inheritance of double flowers in the Stock being the original and classical illustration. The simplest interpretation, to which many of us in England have inclined, is that a segregation, probably somatic, has occurred prior at least to maturation, but those who, like Correns, are unwilling to admit anything which conflicts with the

strict chromosome-theory, seek for some other account. Much ingenuity has been devoted to an attempt to demonstrate the existence of the missing class of pollen-grains, and the numerous papers dealing with this vexed question form a prominent feature of the present volume. Even if it were proved that pollen-grains of the missing classes—always recessive by the way—are produced by the plant in the normal proportion, the peculiarity in their behaviour would remain to be accounted for.

Correns was, of course, one of the rediscoverers of Mendel, in a sense, perhaps, *the* rediscoverer The earliest papers in this volume recall that curious and diverting episode, and the cryptic nature of the first announcements In view of all that has happened since, he may, in any case, find satisfaction in remembering that in 1902, some time before linkage had been observed as an actual fact, he made a suggestion (p. 304 in this collection) as to the linear arrangement of elements in chromosomes and as to the exchanges between them, now spoken of as crossing-over, which in all essentials is that now adopted by the orthodoxy of the day

The frontispiece reproduces a portrait-drawing of the author by Hans Meid, which is a very brilliant performance, both as an exact and penetrating portrait and as a piece of artistic workmanship. In spite of its high price many libraries should get this book, for several of the papers here assembled from various journals will be in requisition for some years to come

(2) Contrasted with the imposing length of Prof. Correns's output, the slender memoir which, by the piety of Dr Iltis, of Brunn, tells us all we are ever likely to know of Mendel himself, makes a modest appearance. The story of his life is in outline familiar. Any details about such a man are welcome, and the few new facts and anecdotes now first made known help us in some measure to reconstruct his personality, but the generation that knew him during the years of his scientific work had almost passed away before his fame began, and as to many essentials we have nothing but surmise.

It is the old story of the boy of sturdy peasant family noticed by an intelligent teacher and selected for education and promotion. We learn that in his village school some natural history was taught at the instance of the great lady of the place, an advantage which no Gymnasium would have supplied. The children even saw something of fruit-growing and bee-keeping in a garden attached to the school, so much so that an inspector, reporting on the school to the Archbishop's Consistory, complained of this disorder (*Wachsthum dieses Unfugs*), which he said was chiefly due to the machinations of a certain Pfarrer Schreiber. That gentleman had done much to promote fruit culture in the district, and as it is also known that Mendel's father took special interest in fruit-growing, we may take it that nature and nurture seem thus to have combined happily for once. Regarding the later stages of his education, details are tolerably full. As a curiosity may be mentioned two fragments of an academic poem in praise of Gutenberg, which, though rather wooden and rough, is not without imagination. It was written when Mendel was seventeen or eighteen, and is interesting as containing the following lines, addressed to the movable types :

> Ihr sollet nach des Meisters Wunsche
> Des Aberglaubens finstre Macht,
> Die lastend sich auf Erden wälzt,
> Zerstreun.

an ominous beginning for a future Prälat, as Dr. Iltis observes.

The funds for his further education were provided by a sort of mortgage of the small paternal property to Mendel's brother-in-law—a remarkable document which survives It gives a full inventory—two horses, four cows, one heifer-calf, one bull-calf, etc.—so that a clear picture of the family circumstances is before us Being destined for orders and the teaching profession, he was sent for his continued education in "Philosophy" to an establishment at Olmütz, where his health seriously broke down more than once. Financial difficulties also supervened, and, as Dr Iltis says, it hung by a hair whether there should be one peasant the more and one immortal discoverer the less in the world. Money was found by the devotion of a sister, then unmarried (whose three sons afterwards became Mendel's especial charge) But the strain to health lasted, and Mendel, when his course of "philosophy" was at length over with distinction, felt unequal to renewing such an effort and consulted a certain Prof. Franz as to his future Franz had some influence with the Brunn cloister, and, having great confidence in Mendel's character and abilities, got him admitted to the brotherhood.

The chief authority for this part of Mendel's career is a brief autobiography which he prepared later on (*æt.* 28) when he was a candidate for a permanent post as a teacher in the Znaim Gymnasium. He had already a post as assistant in this Gymnasium, but in order to become permanently appointed, he required a certificate of official recognition. The procedure on this occasion (1850) strikes us as singular. He had first to supply a full and intimate history of his career, mental development, etc., together with an inquisitory report on his behaviour from the teaching staff of Znaim. They speak well of him, the only charge they have against him being that he had been six times to the theatre,

admittedly a venial error since on each occasion he had gone in the company of a colleague. The next step was the preparation of what must have been almost small treatises, one on meteorology, the other on a geological subject, for which six or eight weeks was allowed. These were referred to experts, and, in addition, to a literary assessor, who all reported upon them at elaborate and pedantic length. Ultimately, on the unfavourable verdict of the geologist, he was rejected. The papers with the reports have been preserved. We get the impression that if the business of academic education was always conducted on those lines, he was well out of it. He would have had little time for peas. So he returned to the Brunn fraternity, teaching without a qualification. The failure anyhow had one very good consequence, for it led indirectly to his being sent to the University of Vienna for two years, apparently with a subsidy from his cloister. In 1856 he made a second attempt to obtain the official qualification necessary for the teaching profession (p. 59), offering then physics and natural history. The result is not clearly recorded, but he was evidently rejected, for until he became Prälat he always figures as "Supplent," not lecturer or professor like his colleagues. None the less his fame as a very successful teacher still survives in Brunn, and these incidents provide ironical commentary on the public utility of a highly regulated educational system.

Mendel's pupils contribute the interesting reminiscence that at some early date one of his two rooms at the cloister was given up to birds and to mouse-breeding, and his biographer conjectures that possibly dominance and segregation were first seen in the mice. Dr. Iltis points out that some experiments with peas must have been already in progress in 1854, for in that year Mendel published an observation on *Bruchus pisi*, which had been damaging peas near Brunn. His interest in the species problem was probably aroused by Gärtner's experiments, though that must be uncertain. How the work fell unnoticed we all know. In spite of an exchange list of 120 copies which went to the various libraries and 40 private *separata*, not one soul took any heed of it. He remained alone. After his immense labour he found not a single creature who understood, not one who believed him. As bad luck would have it, he then started on Hieracium, and then in an evil moment he tried to interest Nägeli, whereupon ensued that tragic correspondence which completed the catastrophe. Nägeli understood him no better than the citizens of Brunn, and, after waiting two months, replied from Olympian heights that the pea experiments seemed to have only just begun, and that he had better go on with Hieracium. The later letters all relate to Hieracium. Nothing more is said about the peas. Nageli is known to have sown the peas which Mendel sent him, but there is never a word as to how they behaved. Hieracium must have been a crushing disappointment, for apogamy was not discovered until long after. That was not Nägeli's fault; but perhaps we may draw the moral that a discoverer of something really new, wishing to find sympathy and encouragement, does not act wisely in appealing to the highest established authority on that particular subject. Dr. Iltis pessimistically remarks that his remedy would have been to have published it all in a "stattliches Buch," as no modern investigator would have neglected to do—something more like Correns's, in fact. This course, nevertheless, has also been known to fail.

All attempts to find the records of Mendel's experiments on bees have failed. We have only the plan of his hives, preserved by the carpenter. He worked on many other subjects, notably Fuchsia, but of these investigations also the results are lost.

We have next a full account of Mendel's meteorological observations, and the life concludes with a detailed history of his "fight for right" against the vindictive taxation of religious houses which was instituted by the Austrian Government in 1874, another painful story. At first he was backed up by the heads of other convents and by the brethren in his own, but after a while they all abandoned the struggle. Once again, in this last enterprise, he was utterly deserted and alone. His obstinacy was such that doubts of his sanity were professed. Whether he was right or wrong it is hard to say, but at least he bore himself throughout as a brave and resolute man should.

The second half of the book gives an account of Mendelian doctrine and its later developments up to the present time. This is very well done, and it supplies in a compact form as good an epitome of the modern science of heredity as has yet appeared.

Dr. Iltis is convinced that Mendel was virtually a freethinker, and only officially a Catholic, interpreting various details in this sense. That he had no special call to clerical work is clear. In his early days this was commented on by a superior who, reporting to the Bishop that he led a modest, religious life, combined with much zeal for the sciences, adds that he had little aptitude for the care of souls. Ministration to the sick and dying distressed him so much as to induce serious illness, presumed to have been a sort of hypochondria. Without much stronger evidence I should hesitate to accept Dr. Iltis's judgment, which is tantamount to a charge of active insincerity. Rather I should suppose that Mendel's position was that of numberless honest men in all ages the world over, who can take things as they find them. Nothing at all suggests that

considerations of faith or doubt had much interest for him, or that he was ever in the position of having to take a side on such questions. Probably they never troubled him one way or the other. I imagine Mendel as a man full of practical good sense, with an exceedingly clear head, thinking in well-divided compartments, rarely disturbed by the eccentricities of genius. We are told that he was not given to brooding or to sentimentality, that he was devoid of music and cared nothing for "Belles Lettres." But when roused he showed, nevertheless, that he had in him a strong element of the martyr, as appears very plainly from the protracted resistance to authority which embittered the last ten years of his life; and *prima facie* such a man is scarcely one whom we need suppose consciously guilty of long-continued sophistry or dishonourable compromise. With this reservation we may be grateful to Dr Iltis for a masterly book, in which all too scanty materials have been used to the greatest advantage, and not least for having rescued one most excellent photograph (p. 53), from which we can at last see exactly how Mendel looked at about the time of his discovery.

W. BATESON.

Tropical Medicine in the Far East.

Far Eastern Association of Tropical Medicine. Transactions of the Fifth Biennial Congress held at Singapore 1923. Edited by the Hon. Dr. A. L. Hoops and Dr. J. W. Scharff. Pp. xx + 974 + 86 plates. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 40*s.* net.

THE report of the transactions of the fifth biennial congress of the Far Eastern Association of Tropical Medicine, held at Singapore in September 1923, forms an imposing volume. Since time and distance rendered it impossible to send proofs of the various papers to the authors for correction or revision, a very high meed of praise is due to the editors, Dr. A. L. Hoops and Dr. J. W. Scharff, for the excellent way in which they have performed their arduous work. Previous congresses had met in Manila (1901), Hong Kong (1912), Saigon (1913), and Veltevreden (1921). The president-elect for this, the fifth congress, was Dr. A. E. Horn, who, however, had in the meantime been appointed medical secretary at the Colonial Office and was, therefore, unable to be present, the chair being taken by Dr. A. L. Hoops.

Of the seventy-eight papers submitted, all except five are reproduced in this volume. In a review such as this it is obvious that all cannot be mentioned in detail, and where there is such a feast of good things, it is a somewhat invidious duty to have to make a selection.

The presidential address is an example of what such an address should be—not a detailed account of some special matter to which the author has particularly devoted himself and which may be of little interest to a large proportion of his audience, and, from its very nature as a presidential address, not open to criticism and discussion; it is an introduction on matters of general interest, in this instance "The Prevention of Disease in the Tropics." A series of papers dealing with malaria and cognate matters occupies the foremost place among the more detailed scientific communications. The opening address, by Sir Malcolm Watson, constitutes an excellent brief review of a vast subject and points out the important fact, too often forgotten or neglected, that all malarious districts cannot be dealt with by a single uniform method, that the prevalent idea of indiscriminate clearing of jungle or bush may do more harm than good by getting rid of non-malarial mosquitoes and facilitating invasion by malaria vectors. This is well exemplified in a concrete instance by the succeeding paper on the "History of Malaria at Gemas." Dr. Howard deals with control of the disease on Malayan rubber estates, and Dr. Walch's paper is stimulating as paving the way for investigations into the reasons why one species of Anopheles may carry malaria in a district while others fail to do so. Lieut.-Col. Christophers contributes an enlightening paper on a method of more accurately measuring and expressing the results of examination for splenic enlargement in children than that generally in vogue, in that the notation recommended shows not merely the degree of enlargement but also that of displacement. The paper on the "Treatment of Dementia paralytica by Malaria Inoculation" will be read with interest by alienists in England and other places where the method is now on its trial.

Dr. Fitzgerald writes on the fascinating, though little understood, conditions of amok and latah, and Sir David Galloway follows with a more detailed account of the former of these. Dr. Stanton sheds further light upon the vexed question of beriberi and its control. He discusses briefly various theories which have been advanced from time to time, and, so far as is possible in the case of a disease of still undetermined etiology, bases the measures of control on a scientific foundation. Dr. Noel Bernard contributes an account of his researches into the relation, or possible relation, with beriberi of the organism isolated by him from the blood of certain patients with febrile and asthenic symptoms, and denominated the *Bacillus asthènogènes*. Further evidence will be needed to convince the impartial critic of its causal connexion with beriberi. As the last of the beriberi series, Lieut.-Col. Megaw summarises the beriberi problem in a paper which will be of interest to research workers and practitioners alike. He points out that not only isolated cases but also explosive outbreaks of this disease occur in which food deficiency

can apparently be excluded, and he also stresses the fact that the question of possible poisons in rice has not yet been efficiently studied.

Another group, of six papers, are devoted to ankylostomiasis. The paper by Prof. de Langen on the toxic origin of the anæmia in this infection is of outstanding scientific interest. Dr. Wu Lien-Teh writes as interestingly as ever on pneumonic plague, a subject which he has made peculiarly his own. There are six contributions on leprosy. Two of these deal more particularly with medicinal treatment, three with statistical and administrative aspects, and one with the ocular conditions and complications. This last is good reading, but partakes rather of the nature of a compilation.

The latter half of the report will be widely read by tropical practitioners. It comprises thirty-five papers of a miscellaneous character. Unfortunately, space will not permit of our referring to all of them. They range from a paper proposing the question, "Has Parasitology a Place in the Medical Curriculum?" to one on the chemical composition of gall-stones. The title of the former should be "Ought Parasitology to have a Place?" Considering that the audience consisted of tropical practitioners, the answer might be expressed in a single word. Of the remainder, special mention must be made of the following:—(1) The article "L'Ascaridiose chirurgicale," by Prof. Le Roy des Barres, since this subject has of late been frequently brought to the notice of those practising in temperate climates also; (2) that on the interpretation of the microscopic picture in dysentery, which covers more than the title would lead one to infer, and points out the great importance for all medical men working in the tropics to have some degree of laboratory experience; (3) pseudo-typhus of Sumatra; (4) two papers on Encephalitis lethargica, the first from the clinical, the second from the experimental point of view; (5) Prof. Toyama's interesting and instructive paper on lacquer dermatitis; (6) lastly, Sir David Galloway's paper on opium-smoking. The last named does not appear from the report to have elicited as much discussion as it deserved. The reputed harmful effects of this habit, or rather custom, are matters about which we would have liked to hear more at such a gathering as this, where many of the audience must have had first-hand experience. We are more than glad to see that he maintains the view that opium-smoking is comparatively innocuous; at all events considerably less harmful than the habits which the opium-smoker develops when this indulgence is denied.

As regards the work in general, the misprints are remarkably few for so large a production, as are also mistakes in nomenclature, of which we may cite *Ankylostoma canium*. The papers from Japan lose something of their value by treating too much of the historical aspects of the subjects, after the manner of a German doctorate thesis, and we note that in an article on recent progress in parasitology made by Japanese investigators, such matters as the mode of infection by Ancylostoma larvæ (1912), that of Ascaris discovered by Stewart in 1917, the discovery of *Metagonimus yokogawai* which occurred in 1910, and the life-history of *Paragonimus westermanii* worked out ten years ago, all receive detailed accounts. This might have been omitted and the space thus set free could have been profitably given up to an index, which would further enhance the value of a volume such as this. The photographs and illustrations are mostly good and are excellently reproduced, and the standard of the various contributions is, on the whole, so high that the Far Eastern Association, if future conferences maintain the standard of the last, will gain a world-wide reputation for advancing materially the solution of the many still obscure problems of tropical medicine.

H. HAROLD SCOTT

Electrical Instruments.

Electrical Measuring Instruments. By Dr. C. V. Drysdale and A. C. Jolley. Part 2: Induction Instruments, Supply Meters and Auxiliary Apparatus. Pp. 475 (London: Ernest Benn, Ltd., 1924.) 55s. net.

THE first volume of Messrs. Drysdale and Jolley's work on electrical measuring instruments, which was noticed in NATURE of August 30, 1924, p. 304, dealt with commercial and indicating instruments. In the second volume, which has recently appeared, the authors carry the work a stage further, covering supply meters, induction instruments and auxiliary indicating instruments.

The opening chapter contains a detailed description of the various types of supply meter and demand indicator. There have been several books published already on electricity meters which cover the same ground, and one is inclined to criticise the inclusion of some types of meter which are now almost obsolete. As in the previous volume, the instruments are described in great detail and much practical information is given about their mechanical construction. The tables of temperature coefficients of supply meters and the curves showing the effect produced by tilting will be of value to Central Station engineers who have to use them.

"Induction" instruments are dealt with in the next chapter, which is one of the most complete and exhaustive studies of this type of apparatus that have yet been published. The theory of the induction ammeter and voltmeter and of the induction type wattmeter and energy meter (including the Sumpner

wattmeter) is given. A valuable table showing the torque exerted and the power consumed by induction supply meters is included, and a considerable section of the chapter deals with the "shaded pole" type of instrument. The simplicity of the induction type supply meter has encouraged its use, but, as the authors point out, these meters require the most careful design if they are to give accurate records of the energy used in a supply circuit. This chapter is characterised by the same care and thoroughness of treatment as the preceding parts of the book.

The chapter on recording instruments is also very complete. Not only are the more usual types of recording instruments mentioned, in which the record is made by a moving pen, but also those giving intermittent records by the puncturing of paper by a spark

A chapter is given to the various forms of frequency and phase meters. The types of frequency meters described include those with vibrating reeds as well as the electro-magnetic type, power factor meters are discussed and the chief types described. Devices for increasing the range of alternating current instruments occupy another chapter, which is concerned mainly with the various forms of potentiometer, and with potential and current transformers. The literature of this subject is very meagre, and the information included will be of value to those who have to deal with the design of these instruments

A very important chapter deals with devices for mechanical testing, that is, with tachometers, stroboscopic instruments, brakes (including the well-known eddy current brake), and torque recorders. Later, a description is given of synchronising devices and synchronoscopes, and leakage indicators, ohmmeters, and the well-known "megger" are described.

The final chapter deals with test-room equipment, and includes a description of the apparatus necessary for the calibration of indicating instruments, the most important of which is the A.C. potentiometer. Methods of checking the accuracy of meters and a description of some standard forms of wattmeter are given. The last few pages give a short account of some of the bridge methods now used so extensively in connexion with telephone work for measuring capacity, self-induction and mutual induction, as well as apparatus for testing the magnetic quality of iron.

Although the two volumes cover a wide field, the work is still incomplete. If the authors could see their way to publish a third volume, such as is suggested in the preface, which would deal with laboratory instruments, the value of the book would be much increased. The two volumes that have been published already, however, are a mine of information on electrical measuring devices.

Our Bookshelf.

Psychology and the Sciences. Edited by Dr. William Brown; with Contributions by Dr. J. S. Haldane, Dr. R. R. Marett, Dr. F. C. S. Schiller, Dr. L. P. Jacks, Rev. A. E. J. Rawlinson, Dr. M. W. Keatinge, Dr William Brown, Dr. T. W. Mitchell. Pp. vii + 184. (London: A. and C. Black, Ltd., 1924.) 7*s.* 6*d.* net.

It was a happy inspiration of the Wylde reader of mental philosophy at Oxford to gather together the views of representative thinkers in various branches of science with regard to the relations of psychology to the kindred sciences which they represent, either on the philosophical or biological side, as well as to certain applications of psychology to education and medicine Though written on popular lines, the volume is an interesting one; for the authors of the essays, which were originally delivered as lectures at Oxford, have taken their several tasks seriously; and, writing from quite different points of view, have emphasised several important conclusions. One of these is that psychology must be regarded as a legitimate science, following its own scientific methods by using interpretative categories peculiar to itself; and another, that it provides a viewpoint necessary as a completion to those of the other sciences represented by the writers of the essays.

Dr. Haldane's contribution is noteworthy, as stressing the necessity of psychological categories of interpretation as well as biological ones, and denying the possibility of expressing the facts of either science in physical terms. Dr. Mitchell's paper is a guarded statement of the relation of psychology to the facts and conclusions of psychical research The editor's own essay is a reasoned justification of the claims of applied psychology, in one of its principal departments, to an unprejudiced hearing. The sciences with which psychology is compared in the volume are biology, anthropology, logic, ethics, theology, education, medicine, and, if it may be called a science, psychical research. As a symposium on these relations "Psychology and the Sciences" is worth attention; though, of course, it is not the last word on the subject.

Handbook of the Geology of Ireland. By Dr. Grenville A. J. Cole and T. Hallissy. Pp. viii + 82. (London: Thomas Murby and Co., 1925.) 8*s.* 6*d.* net.

The work is based on the late Prof. Cole's contributions to the "Handbook of Regional Geology," published some years ago in Heidelberg, and revised and brought up-to-date by him in collaboration with Mr. T. Hallissy. It is an authoritative and concise statement of the broad features of the geological structure and history of Ireland, and though the size of the volume does not allow of much detail, lists of the various papers dealing with the subject-matter are given at the end of each section.

The general morphology of the island is dealt with, and then follow a number of chapters each dealing with the stratigraphy, distribution, and lithology of a system. Tables giving the correlation of the Devonian rocks of Ireland with those of Britain and the Continent of Europe are included.

Under the heading "Quarternary" is given a

description of the glacial deposits of the country, and the authors support the views held by Close with regard to the centres of distribution of the ice, and those of Hull on the origin of the sands and gravels which sometimes occur between two layers of boulder clay. Both these views have been placed in grave doubt by recently published work, and though some of the papers are included in the bibliography, they are not discussed in the text.

Section III. is an account of the general geological history, and contains much that is calculated to stimulate thought, as does also the following section on orographic elements. The volume concludes with an account of the principal minerals of economic value found in the country

The illustrations include a geological map of Ireland and several sections, but during perusal the lack is felt of a map showing the positions of the various topographic features and towns mentioned in the text.

The Year-Book of the Universities of the Empire, 1925. Edited by W. H. Dawson. (Published for the Universities Bureau of the British Empire.) Pp. xii + 808 (London: G. Bell and Sons, Ltd., 1925.) 7*s*. 6*d*. net

THIS Yearbook, published for the Universities Bureau of the British Empire, has established a claim to be considered not only a useful but an indispensable work of reference for all who are concerned with higher education and research.

The latest edition has just come to hand. Included in a little more than 800 pages are a general survey of the British universities, very full particulars of all the universities within the Empire, as well as some shorter notes regarding the other universities of the world. The book contains also among its valuable appendices information regarding the conditions of entrance to the professions, the various matriculation and other entrance examinations, inter-university scholarships, grants for research, etc., and, what is particularly useful, a list of subjects for specialised study in the universities of the United Kingdom.

A considerable amount of hard work must have gone to the compilation of this volume. The universities of the Empire alone now number 67, and to obtain information regarding their affairs would, in the absence of a volume such as this, necessitate the consultation of a set of calendars constituting in themselves a library of formidable dimensions. The possessor of the volume is spared such a laborious task, and the condensation of so much information has been made possible by a system of abbreviations which is ingenious and easily followed.

We have tested the volume by frequent reference and found it remarkably accurate. It reflects credit alike upon the editor and the publishers.

North Manchuria and the Chinese Eastern Railway. Pp. xiii + 454 + 13 plates. (Harbin, China: C.E.R. Printing Office, 1924.) 6 dollars.

THIS volume was first published in Russian in 1922, but the present edition has not only been well translated, but has been thoroughly revised and considerably extended. It deals mainly with the country traversed by the Eastern Chinese Railway in its course of some nine hundred miles from the Siberian railway to the Ussuri railway on the way to Vladivostock. In this northern part of Manchuria, settlement, mainly by Chinese, dates almost entirely from the opening of the railway in 1903, which allowed the Manchu authorities to carry out their policy of colonisation which had been initiated a few years previously For through traffic between east and west the Chinese Eastern railway is the shortest route, but it no longer has a monopoly since the earlier designed but later constructed Amur line was built entirely within Russian territory.

A short chapter on the physical geography of Manchuria is followed by long and full accounts of the economic development of the country and the waterways and railroads. A concluding chapter deals with the operating of the railroads. The rapid growth of prosperity and the great food-producing possibilities of the country are well brought out There are a number of illustrations, but the maps are weak. Altogether it is a useful volume on a country about which authoritative information is not too easy to obtain.

Algebraic Geometry: a First Course, including an Introduction to the Conic Section By M. P. Meshenberg. Pp. xi + 127. (London: Sidgwick and Jackson, Ltd., 1924) 3*s*. 6*d*. net.

THIS is one of the best introductions to algebraic geometry that we have seen. It is mainly intended to be used as a class-book by senior courses just beginning analytical geometry in secondary schools Within the compass of a hundred pages the author has contrived to give a thorough treatment of the co-ordinate geometry of the straight line and circle, together with a short but very satisfying introduction to the conic sections. The student is evidently given the benefit of much practice in teaching the subject; very many pitfalls which often disturb beginners are pointed out, and the summaries will be found most helpful to learners. We confidently recommend Mr Meshenberg's book both to teachers and to private students; it is worthy of being used very widely W. E. H. B.

Australasia and New Zealand. By B. C. Wallis. (Macmillan's Practical Modern Geographies) Pp. x + 350. (London: Macmillan and Co., Ltd., 1924.) 5*s*.

THIS is a useful addition to the series to which it belongs. Australia and New Zealand receive rather scant notice in most English textbooks, but Mr. Wallis's work fills the gap. He has produced a book which is full of accurate information and is particularly valuable in its chapters on climate—a difficult part of the subject, and one which is too often shirked by writers of textbooks. A great deal of statistical information is given throughout the book. This may not attract some teachers, but certainly should help to give greater precision and respect for facts in the study of geography. The book contains more than one hundred admirable maps, and above a hundred and fifty well-selected illustrations. These features alone give value to the volume.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Wegener's Hypothesis and the Distribution of Micro-Lepidoptera.

ON the suggestion of a friend, I have tested the credibility of Wegener's hypothesis of continental displacement in the light of my knowledge of the geographical distribution of the micro-Lepidoptera, and some observations on the subject may be of general interest

The term micro-Lepidoptera is a popular and not a scientific one, and has various acceptations, but I use it here to denote the Tortrices and Tineæ only, and (except that I shall have occasion to mention one genus of Pyrales) I shall not call evidence in support of my case from other groups of animals and plants, the different modes of distribution, periods of origin, and other conditions appropriate to these would tend rather to confuse the issue than to elucidate it I have always thought that these fragile little insects offer especially trustworthy testimony to former land-connexion, their weak flight forbids even a short voluntary sea-voyage; though they may be carried long distances by gales, their most constant impulse is to avoid this by taking shelter, and those that fail to do so would usually be lost at sea, whilst a large proportion of the species, being restricted by habit to certain food plants in the larval stage, would be unable to establish themselves in a new country where these plants did not exist; and their mode of life is such that other means of distribution (such as ocean currents, transmission by birds, etc.) are in general entirely inoperative Further, the extent of the group is adequate (I am acquainted with probably 30,000 species, constituting some 35 families and 2000 genera) to afford a sufficiently broad basis for reasonable argument Naturally a full treatment is here impracticable, but it is possible to develop a few striking and well-ascertained facts

Wegener gives three maps, reconstructing the globe at different periods. The first of these, representing the Carboniferous era, does not concern us here, since there is no evidence of the existence of any Lepidoptera before the Jurassic. It is probable (and let it be admitted) that in the Jurassic period only primitive forms of Lepidoptera existed, that in the Cretaceous the principal families, as now known, came into being; and that in the Eocene the larger existing genera (those the great specific development and extensive geographical range of which compel us to assign them an origin far back in time) were definitely established. The second map shows the hypothetical relations of the continents in the Eocene, and we see Africa (below the Sahara) and South America in near approximation, and even touching above the equator. There ought, then, to be generic evidence of this. Now Ceromitia (belonging to the "long-horned" Adelidæ, of early type) contains at present 45 African species, being the largest micro-Lepidopterous genus especially characteristic of Africa (which has not been so prolific of large genera as the other continents), and undoubtedly originated there; it also includes 7 species from the Amazonian region of Brazil, and is unknown elsewhere. This is a very remarkable distribution. Tiquadra (Tineidæ), a very distinct form of peculiar aspect, consists of 18 South American species (extending to Mexico), and also 3 African; it is found nowhere else, and its home is clearly American. Polyhymno (Gelechiadæ) is also a genus of striking appearance, and probably of South American origin; it contains 10 American species (North and South), 16 African, and 1 Indian, which may have been derived from Africa. So far as concerns the connexion of Africa and South America, this is evidence as good as could be expected; it demands nearly some such explanation.

We must now consider the more difficult and critical problem presented by Australia and New Zealand. These are represented in the Eocene map as forming one land-mass, completely united also with Antarctica, and by an isthmus-like extension of the latter with South America, the Antarctica portion lying beneath but rather widely remote from Africa, and the Australian portion still more widely remote from India and Asia, but terminally rather approaching the Malay Archipelago. Antarctica is thus brought up into a temperate climate.

Wegener rightly recognises three elements in the Australian fauna—Indian, Malayan, and South American—and describes this feature as being "in most beautiful agreement" with his displacement theory The South American element is expressly stated to have reached Australia through Antarctica, and as on his theory the width of the Pacific Ocean is much increased, it could scarcely arrive otherwise. Machimia (Œcophoridæ) is a considerable genus, commonly attracting attention by its rosy or crimson tints; its distribution is very striking, namely, South and Central America 73 species, North America (to Canada) 10, Japan 1, Australia (almost all East Australia) 47. Not a single New Zealand species! This is by far the best example of generic intercommunication between Australia and South America, and yet New Zealand, theoretically served by the same means of communication, has absolutely no share in the result. My explanation (and it seems to me the only possible one) is that the Japanese species gives the clue, and that the passage was made by the north; the Japanese micro-Lepidoptera are very inadequately known, and I anticipate that more of the genus will be found there. If, however, as is essential on the Wegener hypothesis, Machimia travelled by way of Antarctica, then New Zealand must at that time have been already disconnected and remote But since the other evidences of relationship between Australia and South America are only small, fragmentary, or dubious (as being otherwise explicable), the evidence of relationship between New Zealand and South America should in that case be still more inconsiderable. Let us now examine that.

I mentioned above my intention to quote one genus of Pyrales, because it is particularly illuminating. Crambus is a genus of perhaps nearly 400 species, of which the larvæ feed usually on the roots of grass or sometimes in moss, and therefore find pabulum in all regions; it includes the familiar "grass-moths" of Great Britain (where there are 26 species), and is well represented generally throughout the world except that it thins out in the Indo-Malayan region, and is reduced in Australia to two or three wide-ranging exotic forms; there is no endemic Australian species. In New Zealand there are more than 40 endemic species, forming a very prominent feature of the fauna; they constitute a homogeneous group, with no specific affinity to Australasian forms, but akin to those of South America, which is their only possible place of origin; and I hold, as Wegener would, that they travelled

thence by way of Antarctica (though in my opinion the connexion was made westward of America, and not eastward as he puts it). Then why are there none in Australia? On Wegener's hypothesis this is altogether unaccountable.

There is, however, a further phase of the same question. If New Zealand and Australia are supposed on the hypothesis to be connected with South America by the same Antarctic isthmus, much more therefore are they connected with one another. Those characteristic Australian genera, whencesoever derived, the large development of which indicates antiquity (such genera, older than the American and Malayan elements, must be presumed to be of Indian stock), might confidently be expected to have flourishing colonies in New Zealand. The largest family in either area is the Œcophoridæ, Australia already possesses 1500 described species. Philobota (containing mainly insects of fair size, and often conspicuously coloured) has 278 Australian species, 1 South African, 1 Indian, 2 New Zealand (one of which closely approaches a Tasmanian form); the non-Australian species can only be regarded as chance stragglers. Eulechria has 232 species in Australia (including New Guinea), 4 Indo-Malayan, 1 South African, and 1 New Zealand. In the Gelechiadæ the principal Australian genus Protolechia has 122 species and (with several minor derived genera as well) is wholly endemic, not a single species being found in New Zealand. On the other hand, the characteristic New Zealand Œcophorid genera Izatha (15 species) and Gymnobathra (14 species), both apparently of South American type, are quite unknown from Australia. The amount of community shown here is then no greater than might be expected if the conditions had always been as at present, with New Zealand separated from Australia by 900 miles of sea, but stretching for nearly 1000 miles parallel to its coast, so as probably to catch occasionally a stray insect blown out to sea; indeed, I should have expected a little more than is actually found. Of course there is closer relation displayed in some of the other families, which cannot be discussed here and does not affect my argument; I will only say that it can be explained generally by comparatively recent intercommunication taking place between New Zealand and Queensland by way of New Caledonia.

My conclusion is, then, that if, as appears to be the case, Wegener's views on Australia and New Zealand are an integral part of his scheme, the hypothesis is disproved by facts. I consider that there must anciently have been some better communication between South America and Africa, and that this was probably equatorial and not southern; to that extent I am in accord with him.

EDWARD MEYRICK.

Thornhanger,
Marlborough, Wilts.

The Intensities of Lines in Multiplets.

THE relative intensities of spectral lines belonging to the same multiplet appear to be determined by quantum conditions. The formulæ here briefly presented have been derived from the theoretical conditions imposed by the correspondence principle, and give results in close accordance with the existing observational data in all known cases.

Landé's quantum numbers, R, K, J, have been found to be best adapted to the problem ($2R$ is 1, 2, 3 for the singlet, doublet, triplet systems: $2K$ is 1, 3, 5, 7 for the S, P, D, F series; and J is equal to the ordinary inner quantum number j in systems of even multiplicity, but to $j+\frac{1}{2}$ in those of odd multiplicity). Combinations between terms characterised by the quantum numbers K_1, R_1 and K_2, R_2 may occur when $R_1 - R_2$ is 0 or ± 1, and when $K_1 - K_2$ has any value up to ± 3, but the inter-system combinations for which $R_1 - R_2 = \pm 1$, and the few groups for which $K_1 - K_2$ is ± 2 or ± 3, usually give faint lines and will not be considered here. It is convenient to set $K_1 + K_2 = 2K$.

The more important multiplets show three types of structure (illustrated by examples from the quintet system):

Ordinary	*Rhomboid.*	*Symmetrical.*
$x_4\ y_3\ z_2$	$x_3\ y_2\ z_1$	$x_4\ y_3$
$x_3\ y_1\ z_0$	$x_1\ y_0\ z_{-1}$	$y_3\ x_2\ y_1$
$x_0\ y_{-1}\ z_{-2}$	$x_{-1}\ y_{-2}\ z_{-3}$	$y_1\ x_0\ y_{-1}$
$x_{-2}\ y_{-3}$		$y_{-1}\ x_{-2}\ y_{-3}$
x_{-4}		$y_{-3}\ x_{-4}$

Ordinary multiplets occur when $K_1 - K_2 = 1$ and $K > R$: that is, when the terms involved have their maximum or "permanent" number of components. "Rhomboid" groups occur when $K_1 - K_2 = 1$ and $K < R$, so that the terms have less than the maximum number of components (these groups appear to have no recognised name, which may excuse coining one). Symmetrical groups occur when $K_1 = K_2$. The intensities of the lines are denoted by x, y, z, the subscripts being the values of l, when $l = J_1 + J_2 - 2K$ when $K > R$, and $l = J_1 + J_2 - 2R$ when $R > K$.

The equations given below have been derived by application of the principles of Sommerfeld and Heisenberg (*Zeitschrift für Physik*, 11, 131, 1922) to Landé's vector-model (*Zeitschrift für Physik*, 15, 189, 1923), using the means of the values of J and K in the initial and final states. This is found to define completely all the terms of the highest order in K, R, l. The terms of lower order are fixed by the condition that the formulæ shall give zero intensity for the fictitious lines which fall into the same rows or columns as real lines, but outside the limits of the multiplet. Very similar formulæ for ordinary multiplets have recently been published by Ornstein and Burger (*Zeitschrift für Physik*, 31, 355, 1925).

Ordinary Multiplets ($K > R$).

$$x_l - u_l = 4RK^2(8K^2 + 4Kl + l^2 - 4R^2 - 1)$$

$$y_l + u_{l+1} + u_{l-1} = 4RK^2(4R^2 - l^2)$$

$$z_l = u_l = \frac{1}{4}\frac{RK}{2K+l}\{(4R^2 - l^2 - 1)^2 - 4l^2\}.$$

Rhomboid Multiplets ($K < R$).

$$x_l - u_l = 2KR(R+K)(l+2K-1)(l+2K+1)$$

$$y_l + u_{l+1} + u_{l-1} = 4KR^2(4K^2 - l^2)$$

$$z_l - u_l = 2KR(R-K)(l-2K+1)(l-2K-1)$$

$$u_l = \frac{1}{4}\frac{RK}{2R+l}\{(4K^2 - l^2 - 1)^2 - 4l^2\}.$$

Symmetrical Multiplets ($K > R$).

$$x_l + y_{l+1} + y_{l-1} = 4RK(4K^2 - 1)(2K+l)$$

$$y_l = 2RK\left\{2K - \frac{4R^2 - l^2}{4(2K+l)}\right\}(4R^2 - l^2).$$

Symmetrical Multiplets ($R > K$).

$$x_l + y_{l-1} + y_{l+1} = 4RK(4K^2 - 1)(2R+l)$$

$$y_l = 2RK\left\{2R - \frac{4K^2 - l^2}{4(2R+l)}\right\}(4K^2 - l^2).$$

The sum-rules of Burger and Dorgelo (according to which the sums of the intensities in successive

rows or columns are proportional to the corresponding values of J) follow as deductions from these formulæ. The sum of the intensities for the whole multiplet is in all cases $16R^2K^2(4K^2-1)$ The formulæ for symmetrical groups give intensity zero for the last s-line when $K=R$ This is the line excluded by Landé's rule, both inner-quantum numbers being zero; so that this rule too (in the present case) appears as a deduction from the correspondence principle. In symmetrical groups, when $R>K$, the later s-lines come out very faint, and when $2K=5$, $2R=7$, s_{-3} comes out zero This is an excellent agreement with observed facts, previously quite unexplained.

The few published quantitative measures of line intensities are in excellent agreement with the theory. A more comprehensive test is found in King's extensive series of estimates of intensities in arc spectra Comparison for the doublet and triplet systems shows that King's tabular numbers are very nearly proportional to the square roots of the actual intensities

Results for some of the most characteristic and important groups are given below. For the measured groups, the sum of the computed intensities has been made equal to that of the observed For King's estimates the sum for each multiplet has been multiplied by such a factor as to make it 100 R, means taken of the results for groups of the same type, and the square roots of the observed intensities have been similarly treated for comparison.

The x's are given first, then the y's, then the z's (separated by semicolons), means have been taken of those observed y's in symmetrical groups which should theoretically be equal (The observed differences are not serious)

QUANTITATIVE MEASURES.

Triplet System

PD	Obs	100, 54, 25, 19, 18, <1
	Comp	100, 54, 24, 18, 18, 1·2
DD'	Obs	100, 56, 37, 14·5, 13
	Comp	102, 57, 37, 13, 12

Quintet System:

DD'	Obs	100, 46, 19·5, 3, 0, 24, 34, 24, 13·7.
	Comp	108, 50, 18, 3·6, 0, 22, 29, 25, 14·4.

KING'S ESTIMATES

(The figures in parentheses denote the number of groups combined to form the mean values.)

Triplet System:

PD	Obs	47, 36, 25, 19, 19, 4
(15)	Comp	48, 35, 23, 19, 19; 5.
DD'	Obs	41, 30, 25; 14, 13
(5)	Comp	40, 30, 24, 14, 14
DF	Obs	48, 36, 35, 14, 14, 3
(13)	Comp	48, 40, 32, 14, 14, 2
FF'	Obs	42, 35, 29, 11, 11
(8)	Comp.	42, 35, 30, 11, 10
FG	Obs	50, 40, 36, 10, 10, ?
(9)	Comp	48, 42, 37, 11, 11, 1·3

PP' Groups.

Triplets:	Obs	44, 18, 0; 24, 20.
(10)	Comp.	41, 19, 0, 24, 21.
Quartets:	Obs.	52, 20, 13, 28, 28
(3)	Comp.	48, 17, 13; 31, 30.
Quintets:	Obs	57, 10, 17; 44, 39
(2)	Comp	56, 16, 22; 39, 39.

PD Groups.

Quartets:	Obs.	50, 35, 23, 27, 28, 25, 7, 5
(7)	Comp.	50, 36, 23, 24, 26, 23, 8, 10.
Quintets:	Obs	55, 40, 23; 32, 31, 26; 10, 16, 17.
(9)	Comp.	54, 40, 24, 28, 31, 27; 11, 15, 18.
Sextets:	Obs	70, 46, 25; 31, 35, 31; 15, 22, 24.
(7)	Comp	62, 45, 27; 33, 38, 33; 14, 21, 27.

DD' Groups

Quintets:	Obs.	53, 31, 18, 6, 0, 17, 22, 19, 13.
(6)	Comp.	43, 29, 17, 8, 0; 19, 22, 20, 15.
Sextets:	Obs.	46, 26, 16, 1, 9; 26, 27, 26, 20.
(4)	Comp.	47, 31, 17, 3·5, 11, 22, 26, 26, 21.
Septets:	Obs.	50, 36, 18, 0, 20, 28, 29, 33, 24.
(1)	Comp	53, 34, 17, 0, 18, 26, 32, 31, 25

DF Groups.

Quintets:	Obs	54, 39, 33, 22, 13; 15, 20, 17, 15, 6, 8, 8.
(12)	Comp	47, 39, 31, 24, 17; 17, 21, 20, 17; 5, 6, 6.

Full details will be published in the Proceedings of the National Academy of Sciences.

HENRY NORRIS RUSSELL.

Mount Wilson Observatory,
Pasadena, California,
April 20.

For the benefit of readers of NATURE interested in the subject, it may be convenient to record here the fact that Prof Russell's formulæ for the intensity ratios in multiplets agree with those given recently (and clearly independently) by Kronig, *Zeit fur Phys.*, 31, p. 885, published April 14, 1925. The final formulæ of Kronig and Russell differ only in superficial algebraic form, they are based on slightly different types of appeal to the Correspondence Principle. The present letter analyses far more experimental material than Kronig's paper [EDITOR OF NATURE.]

The Positive Electrical Drift in the Air.

THE only reason advanced by Dr Chree (NATURE, April 11, p. 531) in support of his contention that smoke is responsible for atmospheric electricity in towns, is the fact that atmospheric pollution is worst when the potential gradient is abnormally high

The conditions under which pollution accumulates —the absence of convection currents—are the same for all variable locally produced constituents of town air

Of these variables I have indicated those which possess an electric charge, namely the positive gas ions poured out by steam locomotives, as the chief cause. I can find no positive charge on smoke. It possesses the property of discharging positively and negatively charged conductors, due to accompanying ionised air, still noticeable some metres to leeward; hence the potential gradient near chimneys is *lowered* in that direction.

The potential gradient at my laboratory at Plaistow ranges from 50 to 300 per cent. higher with N.W. winds than with N.E, E., or S.E., due to the presence of Stratford Station and its extensive connexions 1½ mile distant in the former direction. Smoke pollution as judged by horizontal visibility appears to be much the same in either direction.

The electrical properties of mists and clouds indicate that the natural positive gradient is due to positive gas ions distributed throughout the lower atmosphere—the dominating effect of the artificially produced ions near steam railways being due to their relative nearness to the earth in the neighbourhood of the source.

Country fogs exhibit a very high positive potential at ground level. The gradient is normal a little above the mist. The positive gas ions act as Aitken centres of condensation for water vapour. The positively charged water droplets, simulating the behaviour of Millikan's oil-loaded electrons, settle down in still air, and the potential gradient at the earth's surface increases owing to the inverse square law. On

dispersal of the mist the positive gas ions regain their mobility, and in consequence of mutual repulsion and aqueous convection currents, uniform distribution is re-established.

The positive envelopes attracted to and surrounding isolated negative clouds and their aqueous discharges, when they descend from the electron-charged upper air into the lower atmosphere, afford striking proof of the presence of positive ions in the latter.

The violent fluctuations seen as successive low clouds approach an observer can be interpreted in terms of envelopes and central zones or their precipitates. The unstable electrical systems so formed may result in electrical discharge along the surface of separation in the cloud, or the surface and the earth, according to circumstances

For purposes of international comparison, all measurements of potential gradient should be excluded when mist, clouds, and locomotive drift are present. They are merely local phenomena

I believe trustworthy readings are only occasionally obtainable within thirty miles of London, or five miles of a railway line The Channel or Scilly Isles, or some south-western promontory, might provide a suitable site.

I do not doubt that curves plotted from such restricted data would show a nightly minimum and a daily maximum. If the natural potential is due to photoelectric ionisation of the air, with electronic concentration by diffusion in the outer low pressure regions, and a corresponding accumulation of positive ions in the lower, in a manner somewhat analogous to the diffusion potentials in electrolytes investigated by Nernst in 1889, the cessation of the process, and some recombination at night, and a maximum activity during daylight, are to be expected

If homogeneity is as important a factor in long range electrical transmission as in acoustical, daylight ionisation may be partly responsible for the superior nightly reception by wireless at distant stations

WILLIAM C. REYNOLDS.

"Wharfedale," Upminster, Essex,
April 28.

Ultra-violet Radiations and Antirachitic Substances.

IN *Science* (1924, 60, 274) Kugelmass and McQuarrie published a preliminary account of experiments they had carried out which led them to think that substances like cod liver oil which possess antirachitic properties emit ultra-violet light on undergoing a process of auto-oxidation. Their technique was briefly as follows. The cod liver oil was made alkaline with caustic potash, and oxygen was bubbled through; the oxidised oil saturated with oxygen was then placed in a beaker, and over it was placed an air-tight photographic plate-holder made of lead containing a sensitised plate. The plate-holder had let into it two windows, one made of quartz and the other of glass. The face of the plate-holder containing these windows was placed directly over the oxidised oil, which was kept in the dark for twenty-four hours. On development the plate showed an image corresponding to the position of the quartz window. It was concluded that this effect was produced by ultra-violet radiations emitted by the oxidised oil since no image was produced where the glass window had been, and the possibility of direct chemical action was excluded by the plate-holder being air-tight.

Working independently, we have both failed to confirm this work. As Russell (Proc. Roy. Soc., B., vol. 80) and others have shown, many substances undergoing auto-oxidation will cause fogging of a photographic plate directly exposed to the material itself, and it can easily be shown that the reacting substance is a vapour obeying the laws of diffusion, etc If care be taken to exclude this vapour or gas from coming into direct contact with the plate, no fogging will take place We conclude, therefore, that either the plate-holders used by Kugelmass and McQuarrie were not gas-tight, or that their results are attributable to the quartz used as a window in their apparatus, for the following reasons

We have observed that fused silica objects after exposure to ultra-violet light emit a phosphorescence which will fog a plate Generally we have found that fused silica ware shows this property, and that optically worked articles do not, it being possible that this is due to the inclusion of small bubbles in the fused quartz We have been privately informed that both Lord Rayleigh and Prof. E. C C. Baly have previously observed the phenomenon, but but we have not been able to trace any statements about it in the literature

The phosphorescence is really very remarkable if a piece of fused silica be exposed to the radiations of a quartz mercury vapour lamp for several minutes and then warmed to accelerate the emission in a darkened room The important point from the point of view of the experiments we are considering is, however, that quartz which has been exposed to ultra-violet light may continue to emit rays capable of fogging a photographic plate after twenty-one days at room temperature.

We think it of interest to direct attention to this property of silica, especially as it seems to provide a possible explanation of the results of Kugelmass and McQuarrie, which we have been quite unable to confirm when we took care to use silica which was not emitting a phosphorescence.

J. C. DRUMMOND.

University College,
London

T. A. WEBSTER.

National Institute for
Medical Research,
Hampstead.

Luminescence of Solid Nitrogen and the Auroral Spectrum.

WITH regard to the statements made by Prof McLennan in a letter to NATURE of January 10, I shall be glad if space can be afforded me for a few remarks.

1. From my first experiments of January 1924 I found that N_1 was a band extending between λλ 5525 and 5670, and that this band had some structure. Spectrograms taken with a spectrograph of high dispersion, which I obtained in March of the same year, showed that the N_1 band consisted of three maxima From my point of view, however, this fact was not regarded as anything essentially new, and the material for accurate wave-length measurements was collected for later treatment. Thus I observed the three maxima of N_1 several months before Prof McLennan announced the fact at the International Congress of Refrigeration on June 17

2. The essential point in our discussion is whether Prof McLennan is right in assuming that each of the three maxima of N_1 is to be regarded as a spectral line with a definite wave-length With regard to this point, I can refer to my previous publications and to more complete publications which are soon to appear, from which it will be evident that the maxima are moving and that the band N_1 approaches the auroral

line by diminution of the size of the particles. The correctness is also confirmed by a number of experiments recently carried out at the laboratory of Leyden. A preliminary note on some of these results is communicated to the Academy of Science of Amsterdam and to the French Academy of Sciences.

3. My remark in my letter to NATURE of November 15 regarding the experimental arrangement had, of course, no reference to the general equipment of the Toronto laboratory, but only to the special arrangement used for exciting and studying the luminosity from solidified gases, and I directed attention to the experimental arrangement to explain our points of divergence, and of course not on account of those facts on which we agree, such as the structure of the N_1 band from pure, solid nitrogen So, for example, I thought that in this way I might possibly explain why Prof McLennan had come to the wrong conclusion, that the N_1 band originated from a *gaseous* state of nitrogen, and that he had not been able to interpret rightly the luminescence from argon

4. For a more complete discussion of the nature of the luminescence from solidified gases and its connexion with cosmic phenomena, I must refer to my publications. L. VEGARD

Physical Institut, Oslo

The Elimination of Mental Defectives.

IN the May issue of the *Nineteenth Century* Prof Punnett describes in an interesting way the general scope of the recent advances in genetic research, a subject on which the public certainly need much instructing. He repeats certain figures, however, all doubtless perfectly correct, which were calculated for him by Prof G H Hardy, and on this subject we should like to direct his, and his readers', attention to the comments thereon made by Mr R. A Fisher in vol 16, page 114, of the *Eugenics Review* If those criticisms are correct, and no arguments to the contrary have been forthcoming, the elimination of the feeble in mind by segregation might, at first at all events, be a far more rapid process than Prof Punnett's figures would lead us to suppose

The argument is too long here to be reproduced in full, but I may mention that whilst it is truly said that on certain assumptions it is seen that it would be possible only to reduce the proportion of defectives by segregation or sterilisation from 1 in 1000 to 1 in 10,000 in 68 generations, yet on the same assumptions it can be proved that it could be reduced by more than 17 per cent in a single generation Moreover, the assumptions made are very questionable, and a more probable hypothesis indicates that the reduction might be so much as 36 per cent in a single generation. Prof. Punnett also regards genius as probably a quality dependent on a recessive factor, a conclusion in regard to which doubts may also reasonably be expressed LEONARD DARWIN

The Eugenics Education Society,
11 Lincoln's Inn Fields,
London, W C 2,
May 19

Exaggerated Resonance.

IT is well known that the amplitude of response of a syntonic arrangement to a properly timed periodic stimulus, however feeble, is limited only by friction or resistance or other source of dissipation of energy, and that if the resistance could be reduced to zero the response would be theoretically infinite.

In radio telegraphy the response of a syntonised circuit is already very considerable, and I employ a freely oscillating circuit (which I call an *N* circuit) to receive conductive stimulus in a special way from an aerial, and to magnify it until it operates on the grid and filament of a valve. The tuning required is very precise; no reaction or inductive connexion with the aerial is permitted; and alien vibrations can be automatically excluded. The resistance of the *N* circuit is kept down by stranded wire and perfect connexions, but hitherto no attempt has been made to reduce the resistance to nearly zero by liquid hydrogen or helium. I imagine that if such a circuit could be cooled to near absolute zero the response would be something astonishing I am not acquainted with any convenience for trying the experiment in Great Britain, but perhaps Prof. McLennan at Toronto has facilities.

OLIVER LODGE

Quantum Radiation.

IN supplement to my brother's letter in NATURE of May 23, I should like to point out how naturally the radiation formula is obtained, and how inevitably RT, the average energy of the atom between two emissions, enters into it, on the single assumption that the energy of each individual atom increases at a rate proportional to itself, combined with the recognised fact that energy is radiated in quanta (the quantum being called $h\nu$, and being presumably dependent on some arrangement or frequency step inside the atom unknown to me).

Let a quantum be radiated when the individual atomic energy of the right kind attains the value E_1, and let this energy grow continuously from E_0 to E_1, its average value between these limits being RT.

Then, assuming that $dE/E = kdt$, where k is some constant, and t is the controlling variable whether time or otherwise (probably otherwise), two equations follow, namely .

$$E_1 - E_0 = E_0(e^{kt} - 1) = h\nu$$

and $$E_1 - E_0 = k\int E dt = k \,.\, RT\int dt = RT \,.\, kt$$

Thus $kt = h\nu/RT$, and everything follows.

ALFRED LODGE

Huxley's Contributions to the Study of the Invertebrata.

I REGRET to find that in the article on "Huxley's Contributions to the Study of the Invertebrata" in NATURE of May 9, p 734, I inadvertently did injustice to other naturalists past and present.

Thus I praised Huxley for having seen that Peripatus was an arthropod; but the credit for this conclusion really belongs to the late Prof. Moseley, who made preparations and dissections of this animal which clearly showed its arthropod nature and these he demonstrated to Huxley.

Then I credited to Huxley's insight the view which has been sustained by later embryological research, that the formation of the endoderm by delamination is a secondary modification of its original mode of formation by invagination, and also the view that the development of mesoderm by the outgrowth of masses of cells is a modification of its original mode of formation by enterocœlic pouches.

These two theories adopted by Huxley we owe to the penetration and genius of Sir Ray Lankester.

E. W. MACBRIDE.

The Yeasts: a Chapter in Microscopical Science.[1]

By A. CHASTON CHAPMAN, F.R.S.

THE word "fermentation," from *fervere*, to boil or seethe, was at first applied to all cases of chemical change the cause of which was unknown, and which were accompanied by the formation of large quantities of gas, giving the liquid the appearance of boiling or seething In its widest sense the word is still occasionally applied to a number of chemical processes in which micro-organisms are the active agents, such, for example, as the souring of milk, the conversion of alcohol into vinegar, the production of butyric acid, and similar processes. In its restricted sense, however, it is applied to the conversion of sugar into (mainly) alcohol and carbon dioxide gas by means of the organism known as yeast.

In 1680 Leeuwenhoek addressed to the Royal Society a communication headed "De Fermento Cerevisiæ," in which he announced that he had discovered that yeast consisted of small ovoid globules. Of these, which he appeared to regard as consisting chiefly of batches of six, he gives several excellent drawings. When we remember the nature of the magnifying apparatus with which he had to work, and that the average diameter of the yeast-cell is only $\frac{1}{150}$ millimetre ($\frac{1}{4000}$ in.), it will, I think, be realised that Leeuwenhoek had accomplished a very remarkable feat. He did not, however, push the discovery any further, and in this position, curiously enough, the matter remained for more than a century.

In the year 1814 Kieser, in the course of a paper by Döbereiner, described yeast as consisting of small spherical corpuscles, but this statement does not appear to have attracted attention, and about the year 1837 the microscopical character of yeast was again made the subject of investigation, and the true nature of the yeast organism was definitely and independently discovered by three observers, Cagniard de Latour, Schwann, and Kützing. These observers recognised that yeast is composed of a vast number of small transparent globules which reproduce by budding, and consist of a cell wall with granular contents A year or two later Schwann appears also to have observed the formation of ascospores. These observers, and Cagniard de Latour in especial, put forward the view that it was owing to the vegetation of these cells that the disengagement of carbon dioxide gas and the formation of alcohol were due

The microscope having definitely shown yeast to consist of minute living cells—that is to say, of a living organism—it became of high interest and importance to study its life-history, and to ascertain what connexion, if any, there was between the vital functions of the organism and the phenomena of fermentation.

In 1897 Buchner made the very important and interesting observation that the liquid contents of the yeast cell, when added to a fermentable liquid, are able to excite fermentation without the presence of any cells at all. He showed that the production of alcohol and carbon dioxide were the result of the activity of an enzyme secreted by the cell, to which he gave the name zymase As in the case of other enzymes, zymase is very sensitive to external conditions, and is also highly selective in respect of its chemical activities. Thus, so far as is known, the hexoses alone, and of these, only four (*d*-glucose, *d*-mannose, *d*-galactose and *d*-fructose) are directly fermentable, and before the fermentation of other sugars, such as maltose and cane sugar, can take place, it is necessary that they should be converted into one or other of these hexoses. This is, in all cases, effected by enzymes which are secreted by the yeast, and it is very interesting to note that certain yeasts, whilst secreting invertase, and therefore capable of fermenting cane sugar, do not secrete maltase, and are therefore incapable of fermenting maltose. Then again, there are a few yeasts which, in addition to secreting invertase and maltase, secrete lactase, and are therefore capable of fermenting milk sugar

We will now turn for a moment to the consideration of yeast as a living organism The yeasts, as is well known, belong to the great family of the fungi, and may be described as unicellular fungi, reproducing by budding, and capable also of forming ascospores. This latter function is of importance from the point of view of classification, as it serves to differentiate between what are regarded as the true yeasts and certain other closely allied organisms, such as the torulæ and mycoderma In the common process of budding, the bud, which occurs first as a small protuberance on the surface of the cell, quickly increases in size until it has attained roughly the dimensions of the parent-cell, after which it usually becomes detached, leading a separate existence, and reproducing in turn by the same process. It often happens that before the offspring cell has separated from the parent-cell it has itself commenced to bud, and so chains or clusters of connected cells may frequently be seen

In the second mode of reproduction to which reference is made above, the yeast cell becomes changed into an asc, in which are formed a number of spores which may vary from one to as many as twelve, but is usually from two to four The conditions which favour this mode of reproduction are the employment of young and vigorous cells, a moist surface, plenty of air, and a suitable temperature, usually about 25° C. The line between budding and ascospore formation is not very sharp, and it often happens that budding and sporulation may be taking place simultaneously. As a general rule the spores are spherical, but in some of the yeasts they have very characteristic forms. It would seem that spore formation is a provision on the part of Nature for securing the persistence of the species under conditions in which active budding is impossible. It appears, at any rate, to play an important part in the hibernation of yeasts, rendering it possible for them to live through the winter in the soil, or on surfaces from which very little nutriment can be extracted.

In addition to reproducing by budding and by ascospore formation, yeasts are capable of reproducing by still a third method, namely, that of true conjugation. In these yeasts, constituting the genus Zygosaccharomyces, certain of the cells form, instead of

[1] Abridged from the presidential address delivered to the Royal Microscopical Society on January 21, and published in the Journal of the Society for March 1925.

ordinary buds, long beak-like processes When the "beaks" of two adjacent cells touch one another a union takes place, the tips of the "beaks" disappear, and a tubular connexion is established between the two cells, one or both of which then proceed to produce ascospores Of these conjugating yeasts a number of different species have been described, and this sexual process in one form or another appears to be much more common than was until recently supposed

Finally, there is a group of organisms, usually included among the Saccharomycetes, which are capable of reproducing by the process of fission. In these so-called Schizosaccharomycetes the fission of the cell, often accompanied by conjugation, is preceded by the formation of a septum which at once commences to divide into two lamellæ Budding does not occur, but the cells form spores, usually from two to eight It will be seen, therefore, that in the great family of the yeasts many types of reproduction are exhibited--from true conjugation (heterogamic and isogamic) in the case of some, through isogamic conjugation of ascospores formed in the same asc, in others, to complete parthenogenesis, as in the case of many of the better known cultivated yeasts. The industrial yeasts, which appear to be entirely asexual, may perhaps be regarded as retrograde forms descended from higher types in which sexuality was quite clearly marked On this point I do not consider myself qualified to express an opinion

As may well be supposed, in the case of a group of organisms which, although presenting some very important differences, are yet so closely allied, and in which there are very many transitional forms, a great deal of confusion exists in respect of their classification The system at present generally adopted is one based upon that suggested by Hansen in 1904, but it is customary to include the Schizosaccharomycetes which he excluded, and there has been, of course, a natural tendency to include a number of subdivisions The great family of the Saccharomycetes is capable of being subdivided into a number of groups or genera, each of which in turn includes a number of species, considerably more than one hundred of which have been described.

From the foregoing it will have been gathered that the division of the yeasts into more or less well-defined genera has been based almost entirely upon differences in their morphological and physiological characters. For the further differentiation into species it was found necessary, in many cases, to adopt other methods of investigation, such as the behaviour of the yeasts towards certain selected carbohydrates, and observations on the optimum conditions required for the formation of ascospores and of films.

Of the very large number of yeast species known, it may be said at once that only a comparatively few are of industrial importance, and it is customary to divide the various yeast species for technical purposes into the "cultivated" and the "wild" yeasts. The former include brewers' and distillers' yeast in all its varieties —that is to say, yeast which has from the earliest times been used for the production of alcoholic beverages, and has in a sense been cultivated for the purpose. This yeast represents, so far as is known, one species, namely, *Saccharomyces cerevisiæ*, although there are many races and varieties which differ considerably in certain respects, as, for example, in the rapidity with which they bring about fermentation, the degree of attenuation which they can effect, and the flavour of the finished product.

The "wild" yeasts are yeast which occur wild in Nature, frequently having their habitat on the surface of ripe fruits, and often finding their way into the brewery. Some of these yeasts, such as the wine-yeasts, are capable of fulfilling useful functions; others again are, so far as is known, without effect good or bad; whilst others are industrially pathogenic—that is to say, give rise to products which are unpleasant in respect of flavour or smell, or exhibit some other defect, such as pronounced and persistent turbidity.

The importance of these observations in connexion with industrial fermentation processes may easily be imagined Prior to the isolation and study of the various yeast species, and to the microscopical control to which it naturally led, industrial fermentations were very largely a matter of chance. Sometimes the results were good, sometimes they were bad, but none could say precisely why Now all that is changed, and when it is remembered that the industrialist who is concerned with any fermentation process is threatened on all sides by intruding organisms which may have the effect of reducing his yields or spoiling his products, the need for scientific control and for the constant employment of the microscope will be evident

I now propose to consider briefly the cytology, or, if the expression may be permitted, the anatomy of the yeast cell For a great many years after yeast had been subjected to microscopical examination, there was much uncertainty as to whether the cell did or did not contain a true nucleus. Although the existence of a nucleus is now well established, there is still some doubt as to the precise nature—to say nothing of the functions—of certain of the internal structures which the microscope reveals. Wager and Peniston, Guilliermond, Fuhrmann, Henneberg, Meyer and others have published important papers dealing with the cytology of the yeast cell, and have shown that it possesses a well-defined and complex internal structure.

In addition to a nucleus with a clearly differentiated structure and a nucleolus, the cell contains cytoplasm, a chondrium, metachromatic granules, a nuclear and other vacuoles, and certain thread-like structures. The cell wall, about which a good deal of uncertainty exists, appears to consist as a rule of a single membrane, and to have a complex chemical composition.

In addition to these elements, which may be regarded to some extent as structural, there exist in the cytoplasm accumulations of materials concerned in the nutrition or metabolism of the cell, such, for example, as glycogen and fat.

With regard to the functions of these various cell elements it is not yet possible to speak with very great certainty. As in all cells, the nucleus is the main seat, or rather the directing organ, of the physiological functions of the cell. It is all-important in cellular reproduction and division; it plays apparently a prominent part in nutrition, and doubtless in it reside the properties which are hereditary, and in virtue of which one species may be distinguished from another. The chondrium, consisting of two forms of mitochondria, appears to be concerned in processes of nutritional

elaboration, and the nuclear or main vacuole appears to be largely concerned with metabolic processes, and is, according to some observers, the seat of fermentative activity. This latter function has, moreover, been observed to be dependent on the amount of metachromatic granules contained in the cell, the larger the amount of metachromatin (volutin) the greater the fermentative activity; and Henneberg has gone so far as to suggest that the metachromatic granules may be the parent substance from which the enzyme zymase is derived. From this necessarily brief and sketchy account of the yeast-cell anatomy, it will at least be gathered that our knowledge is very imperfect and that we have much to learn, and it may be hoped that expert cytologists may be induced to turn their attention to the elucidation of the subject There can be very little doubt that the results would be of important industrial as well as of purely biological value.

The ordinary microscopical examination of cells which have been subjected to the drastic processes of fixing and staining obviously has its limitations, and modifications of structure, such as must almost inevitably be brought about by the above processes, may very easily give rise to incorrect conclusions in regard to the internal structure of such a delicate organism as the yeast cell. It would almost appear, in fact, that we have gone as far as it is possible to go in this direction, and some improved method of investigation will have to be resorted to if many of the questions which are at present in doubt are to be satisfactorily solved. It is possible, for example, that a very careful microscopical study of the unstained cell by means of ultra-violet light may be helpful in giving us a better insight into its internal structure, and Mr. Barnard has already carried out some interesting experiments of a preliminary character in this direction

When one remembers that the whole of a miniature solar system is comprised within the compass of an atom, it is not, perhaps, altogether fanciful to suppose that the yeast cell—small as it is—may have a much more highly developed internal organisation than has been revealed with our present imperfect means of investigation, and that there may be more or less distinct localisation of the different functions of the cell In this connexion two sets of facts may be briefly referred to.

In the first place, it is well known that the yeast cell, like other living organisms, may be made to perform different functions according to the conditions under which it is compelled to carry out its activities. Thus, whilst the ordinary *Saccharomyces cerevisiæ* normally decomposes sugar with the production of alcohol and carbon dioxide, and only about 3 per cent. of glycerin, it has been found that when the fermentation is conducted in the presence of a considerable quantity of sodium sulphite, the main products of the fermentation consist of acetaldehyde and glycerin in roughly equal molecular proportions, and that instead of the normal 3 per cent. so much as 36 per cent. of glycerin can be produced. In other words, it would appear that the well-known equation representing fermentation, namely,

$$\underset{\text{alcohol}}{C_6H_{12}O_6 = 2C_2H_6O} + 2CO_2$$

has, when the process is carried out in the presence of sulphite, to be written in the following very different and unfamiliar form,

$$C_6H_{12}O_6 = \underset{\text{acetaldehyde}}{CH_3COH} + CO_2 + \underset{\text{glycerin}}{C_3H_8O_3}.$$

In the next place, it is of considerable interest to note that the behaviour of the enzymes within the cell appears to differ materially from that of the same enzymes in the expressed juice. Thus, the acceleration of fermentation by the addition of aldehydes is much greater in the expressed yeast juice than in the case of the living cell, and there are other respects in which the actions proceeding in the juice differ from those occurring within the cell. This seems to suggest that the mechanism of fermentation is in some way directly connected with the organised structure of the cell In the living cell, again, the velocity of fermentation is much greater than in the expressed juice, and it would seem that, in its natural surroundings within the cell, zymase is free to act without the disturbing influences which probably exist in the expressed juice where all the cell contents are mingled, and some substances may well interfere with the activity of others

Cramer (Proc. Roy. Soc., 1915, 88, B, 584) has dealt with this important and interesting point, and has shown that the most striking difference between the action of enzymes within the living cells and their action after extraction is the extreme sensitiveness with which, in the former case, they respond to very slight changes in the surrounding medium, being sometimes retarded, sometimes accelerated, and sometimes reversed. According to Cramer, surface tension would appear to be an important factor, such surface tension being operative, for example, at the periphery of the cell and at the boundaries of the nucleus, vacuoles, granules, colloidal aggregates, etc Thus the conditions for enzyme action may be very different in one part of the cells from those occurring in another part. Under the influence of very slight changes in external conditions there may, for example, take place within the cell a movement of the cytoplasm, or changes in the concentration of the cell constituents which, by altering the surface tension at different parts, may altogether change the conditions for enzymic action.

Even assuming Cramer's explanation to be correct, it still means that the great variations in the physiological and chemical activities of the cell are dependent on internal structure, and it is to this problem that future research may usefully be directed Any great increase in our knowledge of this subject might prove to be of the highest importance, not merely in regard to industrial operations, but also as affording a deeper insight than we yet possess into the true character of the vital activities of the living cell. The results of such an investigation might well prove to be of fundamental importance. In the living cell we have, in fact, a chemical laboratory of the highest efficiency, and of the most remarkable character, and could we but understand and imitate artificially the processes of building-up and breaking-down which are so quietly and so regularly occurring in a single cell of yeast, we should be not only within measurable distance of a new organic chemistry, but we should also be appreciably nearer to an understanding of that greatest of all problems, the nature of life.

Dacca: an Experiment in University Education in India.

THE transition phase, now in rapid progress in all matters connected with government in India, has also exercised a profound effect on university education. In many directions experiments have been made during the last few years Eight new universities have come into being, a number of others are being discussed, while in the older institutions, notably Calcutta and Lahore, an effort is being made to raise the standard of teaching, particularly in science. When it is remembered that many of these developments have taken place during a period of acute financial stringency, the strength of the national movement which has given birth to these changes will be evident.

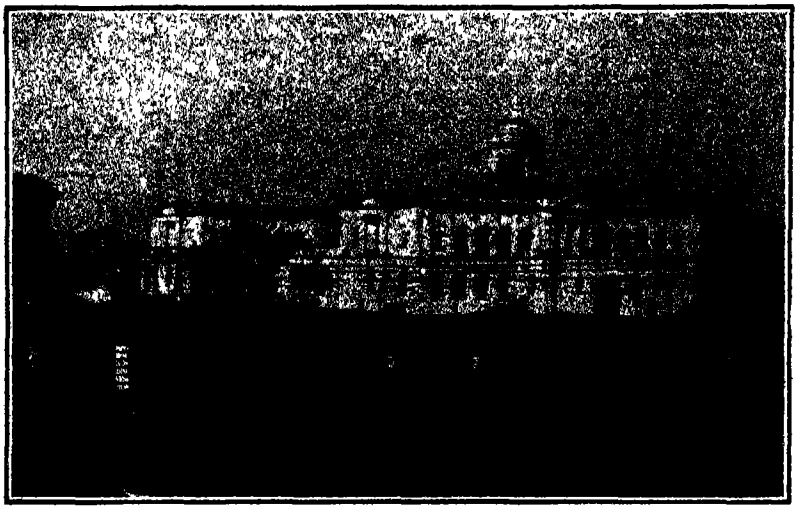


FIG. 1.—University of Dacca. University Court House.

In many respects the new University of Dacca, which was opened on July 1, 1921, is of special significance to those interested in the development of higher education in India This university owes its foundation to the Calcutta University Commission, presided over by Sir Michael Sadler, and is an attempt to remedy, by means of an actual example, the abuses which had gradually grown up in India round the purely examining bodies of the older type. To many of the present university students in India, collegiate life, such as exists in Europe and the United States, is unknown; there are little or no facilities for sports and other forms of recreation, while the inevitable examinations exercise far too great an influence on the teaching. It was felt by the members of the Sadler Commission that a new university, organised on the model of modern British universities, was essential if any real progress was to be made in higher education in India. Dacca was accordingly selected for the experiment, and one of the members of the Commission, Dr. P. J. Hartog, formerly Academic Registrar of the University of London, was appointed the first vice-chancellor.

While these decisions were being arrived at, the prospects of a really notable advance in Indian education were most hopeful. A number of suitable buildings, covering nearly a square mile in area, were immediately available. These had been erected, provided with roads and suitably laid out, for the Government of Eastern Bengal and Assam, which came to an end in 1912 on the re-partition of the Provinces of Bengal, Bihar, and Assam. Included in these buildings were the premises of the Dacca College The area assigned to the University is situated to the north-west of the city of Dacca and alongside the public park of Ramna, and is admirably suited to the needs of a modern residential university. Besides the site and the buildings, a large sum of money, amounting to some 60 lakhs of rupees (about 400,000*l.*), had been set aside by the Government of India for the needs of the new undertaking.

Steps were also taken to recruit the very best staff possible, and to make the teaching of science one of the main features of the University. Unfortunately, by the time Dr. Hartog arrived in India in 1920, the financial situation had reached such a position that the Government of Bengal was compelled to stop all new developments. An era of severe retrenchment ensued, and the new University found itself sadly crippled. The sixty lakhs found its way into the treasury of the Bengal Government when the Reforms Scheme came into operation. Bengal, however, has admitted the moral claim of the University of Dacca to this sum, and has been releasing it at the rate of four lakhs of rupees a

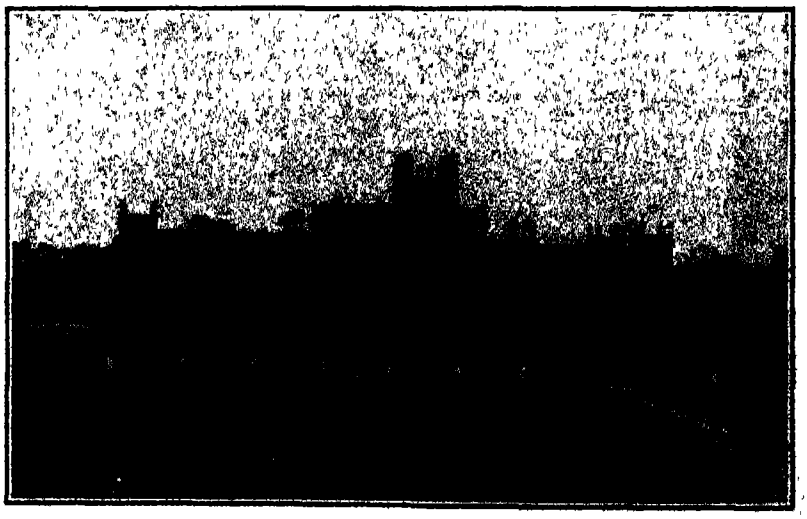


FIG. 2.—University of Dacca. Curzon Hall and Physics Laboratory.

year for capital in addition to a recurring grant of five lakhs. The total annual income and expenditure of the University are now about seven and a half lakhs of rupees (about 50,000*l*.).

In spite of the shortage of funds, however, the University came into being in 1921 with nearly a thousand students and every year the numbers have steadily increased. At the present time nearly 1400 students are in residence divided among the three faculties of Arts, Science and Law. The students, other than those who stay with relatives in the town, live in three residential colleges—known as the Dacca Hall, Muslim Hall and Jagannath Hall—round which the social and athletic life of the University mainly centres. Recently, a new and interesting development has taken place as a result of the residential system. Social service organisations, designed for the uplift of the degraded and the enlightenment of the ignorant, have taken firm root in the University and are doing good work.

On the teaching side, Dacca has broken new ground in several directions. A tutorial system has been established, and the students are taught how to use a library. The tutorial class, as designed at Dacca, is intended to counteract the inevitable evils of the examination room. Examination tends to discourage originality. The tutorial system is designed to foster individual effort, to ensure that each student shall be enabled to learn something of intellectual production as well as of reproduction, so that when he enters the world he will not find himself for the first time confronted with problems to which he had not been taught the answers beforehand. Besides the institution of the tutorial system, the University possesses a good library, the use of which forms an important part of the training of the students. The Sadler Commission in its report stated that in the colleges of some Indian universities, students of university courses read little more than their text-books. This cannot be said of Dacca. The last report shows that 33,982 books were borrowed from the University library during the year. These reforms in the teaching have had their inevitable result. Many of the advanced students have taken up research, and every year a growing number of original papers in languages, history, philosophy, economics, chemistry and physics are being published.

At the Convocation of the University of Dacca on March 6 last, His Excellency Lord Lytton, the Governor of Bengal, in conferring the degree of Doctor of Laws on the vice-chancellor, referred to Dr Hartog's great services in having successfully established a modern university at Dacca, which though only four years old had already made a name for itself in the world. Lord Lytton stated that the establishment of the tutorial system was largely due to Dr. Hartog, who had worked with patience, with courage, and with industry, and their reward was the appreciation of all his colleagues They greatly regretted that that would be the last Convocation at which they would see him as their vice-chancellor.

Obituary.

Prof. Albin Haller, For. Mem. R.S.

ALBIN HALLER was born on March 7, 1849, the eldest of a family of eleven children, at Felleringen, a small village in the Vosges, near Mulhouse. His father was a master carpenter and cabinet-maker, and his mother carried on a small hardware business. In due course he entered his father's workshop as an apprentice, but two years later, and as the result of a conference between his father and a pharmacist of the neighbourhood, young Haller left his native village and became a student in a pharmacy at Münster; his new master, Achille Gault, undertook the literary as well as the scientific education of his pupil, and later installed him with his brother, Léon Gault, a pharmacist at Colmar.

Thanks to the wise counsels and benevolent interest of these two pharmacists, Haller was able to pass his bachelor of science examinations at Strassburg in May 1870. He volunteered at the outbreak of the war of 1870, was assigned to the army medical service, and was drafted to a hospital at Lyons. The close of hostilities found Haller in a difficult position; his father died, and his mother, left with a large family, decided to open a small hotel in order to set her eldest son free to continue his training; whilst the mother thus became a German subject, the son remained a Frenchman, and rejoined his first teacher, Achille Gault, in a pharmacy at Nancy. When the staff of the University of Strassburg was transferred to Nancy in 1872, he became a student in the School of Pharmacy, and was awarded his diploma as a pharmacist in 1873.

The training of a pharmacist in France often led, and still often leads, to a career in pure chemistry; this arises from the excellent chemical education given to the French pharmacist. Further, the fact that Alsace was the seat of many flourishing chemical industries had already attracted to chemistry many young Alsacians such as Wurtz, Friedel, Schutzenberger and Ch. Lauth. Haller's tastes and his many talents impelled him to forsake pharmacy and to devote himself to chemical science, he soon became well known as a chemical investigator, and took his degree of doctor of science at Paris in 1879. He was appointed professor of chemistry at Nancy in 1885, and professor of organic chemistry in 1898; in 1899 he succeeded Friedel in the chair of organic chemistry at the Sorbonne, a position which he retained until his retirement last year under the age limit

During the 'seventies of last century our chemical knowledge of camphor was but slight, partly because of the comparatively small number of camphor derivatives known; Haller attached himself particularly to the problems relating to this ketone and prepared large numbers of new derivatives. His first work related to the behaviour of sodiocamphor, and he was the first to prepare iodocamphor and cyanocamphor; the latter compound led to many new derivatives, such as homocamphoric acid, the study of which threw light on the constitution of camphor itself. He made an exhaustive

study of the condensation products of camphor with aldehydes and ketones, and gave an elegant method of preparing sodiocamphor by the aid of sodamide; he effected the partial synthesis of camphor from camphoric acid, and characterised the isomeric borneols. His study of cyanocamphor led him to investigate the remarkable behaviour of the cyano-derivatives of carboxylic esters and ketones in general, and enabled him to provide a new synthesis of acetonedicarboxylic ester and of citric acid. He published important series of papers on the phthaleins, the anthrones, the indanones and the synthesis of anthracene derivatives, he introduced the idea that the alcohols could act upon esters in the presence of hydrogen chloride in the same way that water acts, and showed that the reaction leads to an exchange of the hydrocarbon radicle in the ester. He carried out a large amount of work on optical rotatory power and refraction constants of organic compounds.

Whilst Haller was a prolific contributor to organic chemistry, he was also an ardent worker in the cause of technical education in France; he recognised both the necessity for stimulating the scientific industries of his country and the hindrance to progress imposed by the tendency towards centralising higher scientific effort in Paris. Thanks largely to his efforts, the Chemical Institute at Nancy was founded, and in due course chairs in industrial chemistry and in tinctorial chemistry were instituted; this was the first of many similar institutions in France. During the war of 1914–1918 Haller acted as president of the French Explosives Committee, and, in this office and in many other directions, his incessant activity and his wide experience rendered invaluable service.

Haller was possessed of great charm of manner, his kindly courtesy, his modest bearing and his fine presence, coupled with the keen interest which he took in the work of his junior colleagues, endeared him to all who had the honour of his friendship. Like so many men of the same age and from the same province, his life had been saddened; he was an Alsacian who felt keenly the loss of his native land in 1870, and he had suffered family losses in the last war. The many honours which came to him could not obliterate these sad remembrances. He died on May 1 from influenza, following upon an accident in the laboratory.

Haller was a Grand Officer of the Legion of Honour; in 1900 he was elected a member of the French Academy of Sciences, and in 1923 became its president. He was well known in England, and had received honorary doctorates in the Universities of Leeds and Cambridge; he was awarded the Davy Medal of the Royal Society in 1917, and was elected a foreign member in 1921. He served several periods as president of the French Chemical Society, and was elected an honorary member of the English Chemical Society in 1908.

WM. J. POPE.

MR H. LING ROTH.

MR H. LING ROTH, whose death on May 12 will be widely regretted, was born on February 3, 1855, and was a son of Dr. Mathias Roth, of Harley Street, London. He was educated at University College School and studied natural science and philosophy in Germany. Prior to going to Halifax in 1888, he had travelled extensively. He was engaged in business, but devoted the whole of his spare time to his studies. About twenty-four years ago he voluntarily undertook the work of superintending the Bankfield Museum, Halifax; about twelve years later he was appointed as half-time Keeper, and afterwards he gave his whole time to the Museum. When he first undertook the superintendence of the Museum, it, like other local museums of that time, was in a chaotic condition, but any one who has visited the Museum from time to time cannot but have been struck by the improvements which he made. It is now a model local museum. In particular it illustrates the growth of Halifax and possesses a remarkable series of appliances illustrating the development of the textile industries. The specimens are carefully chosen, well arranged, and most admirably labelled, so that the Museum is a teaching institution of prime importance. Not only has Mr. Ling Roth given time, knowledge, and skill to the Museum, but he has also enriched it with many donations.

By the death of Mr Ling Roth the science of ethnography loses a student who has not received the recognition that was due to him. This was mainly owing to his quiet, unassuming disposition, and to the fact that he was not connected with a university or large public institution. His work was characterised by painstaking accuracy, and he had a *flair* for collecting specimens to illustrate the particular subject he had in hand. He was a master of the art of collating information and of presenting scattered records in a readable form, which has been of great use to his fellow-students, but in addition, by his own investigations, he has added considerably to ethnographical knowledge. Most of his memoirs and papers have been enriched by his clever draughtsmanship; his drawings bring out just those details which are essential, and thus really illustrate his theme.

The range of Mr. Ling Roth's interests is shown by the following imperfect list of some of his writings: "Crozet's Voyage to Tasmania, New Zealand, etc.," 1891, "The Natives of Sarawak and British North Borneo," 2 vols., 1896; "The Aborigines of Tasmania," London, 1890, 2nd ed. Halifax, 1899; "Great Benin: its Customs, Art and Horrors," Halifax, 1903; "The Genesis of Banking in Halifax," Halifax, 1914; "The Discovery and Settlement of Port Mackay, Queensland," Halifax, 1908; "Oriental Silverwork: Malay and Chinese," 1910; "The Yorkshire Coiners, 1767–1783, with Notes on Old and Prehistoric Halifax," Halifax, 1906; "Sketches and Reminiscences from Queensland, Russia and elsewhere," 1916; "The Maori Mantle," 1923.

Among numerous papers published by the Royal Anthropological Institute may be noted those on the origin of agriculture, salutations, the significance of the couvade, various memoirs on tatuing in Polynesia, Tierra del Fuego, and Tunis, and American quillwork. The series of articles in the Bankfield Museum Notes is of particular interest, among which may be noted the Fijian and Burmese collections; trading in early days; hand wool combing; hand card making; oriental steelyards and bismars; Bishop Blaise, saint, martyr, and woolcombers' patron; and the very valuable series on primitive looms from all parts of the world, which has been reprinted in a separate volume.

A. C. HADDON.

MR. R. B. SEAGER.

WE much regret to announce the death of Mr. Richard B. Seager, the well-known American archæologist and explorer. According to a message from Sir Arthur Evans in the *Times* of May 14, Mr. Seager was taken ill suddenly while on the voyage from Egypt to Crete. He was landed unconscious at Candia, and died soon afterwards on May 12. Mr Seager's achievements as an archæologist won for him a high place in studies connected with the Eastern Mediterranean, and he is probably to be regarded as one of, if not the most, distinguished of the archæologists from the United States who have been connected with the work of the American School at Athens His excavations in Eastern Crete led to a series of discoveries which revealed much fresh material bearing on the earliest culture of the island, and afforded evidence of the state of the arts, as well as of the technology and artistic characteristics of the jewelry, lapidary work, etc , in that early phase of the development of Cretan civilisation.

In his telegram, Sir Arthur Evans alludes to the remarkable *flair* which inspired Mr Seager's excavations in Eastern Crete. This will be admitted by all who have any knowledge of his work ; but he gave ample evidence in his publications that he possessed a sound judgment which, in a sense, was no less remarkable. His published work included three substantial records of his excavations. The first, describing his excavations at Pseira in Crete, was published at Philadelphia in 1910. This was followed by an account of his excavations at Mochlos, published by the American School in 1912, while in 1916 he published a report on his work at the Cemetery of Pachyammos, Crete, as one of the Anthropological Publications of the University of Pennsylvania. Mr. Seager's personal character and charm won for him many friends, by whom his loss is deeply mourned.

A MESSAGE from the Beirût correspondent of the *Times* announces the deaths, in a motor-car accident, of Dr. N V. C. Lothian, Dr Samuel Darling, and Mlle. Besson, members of the League of Nations Malaria Committee. During the War, Dr Lothian was Deputy-Assistant Director of Medical Services in the Near East, where he was employed mainly on anti-malarial work, and since then he has been with the League of Nations. Dr. Darling was connected with the Rockefeller Foundation for medical research.

WE regret to announce the following deaths:

M. Stanislas Meunier, honorary professor in the National Museum of Natural History, Paris, and author of numerous works on the earth, comparative and experimental geology and on meteorites, aged eighty-one

Dr G. L. Spenser, chemist to the Cuban American Sugar Co since 1906, and formerly chief of the Sugar Laboratory of the U S Bureau of Chemistry, on March 23, aged sixty-six

Current Topics and Events.

IN replying to the debate initiated by Lord Olivier in the House of Lords on May 20, on certain questions of land and labour policy in Kenya Colony, Lord Balfour, the Lord President of the Council, took occasion to make an announcement of the highest importance, going far beyond the particular problems of Kenya. After referring to the chapter on research in the report of the Ormsby-Gore Commission on East Africa, Lord Balfour pointed out that "what we want is some machinery by which the larger problems which we now see are presented to us by this vast area in East Africa, and other problems from other parts of our Empire may be more conveniently considered in their entirety." He went on to say: "His Majesty's Government are of the opinion that some institution bearing some resemblance to the Committee of Imperial Defence might be set up for dealing with the purely civilian problems which are becoming more and more insistent in connexion with imperial development."

FROM statements made by Lord Balfour and Mr Baldwin, the Prime Minister, it appears that the Government has decided to set up a Committee of Imperial Research comparable with the Committee of Imperial Defence. This new body will not only be an instrument for acquiring new and needed knowledge, but it will also act as a clearing house of information and as a central co-ordinating organisation, in connexion with the larger problems—economic, racial, scientific—affecting the whole Empire and on the solution of which the future development of the Empire must depend. Like the Committee of Imperial Defence, the new institution will perform no executive action of itself; it will be the direct creation of the Prime Minister, it will advise the Cabinet and provide the machinery for examining problems with which there is at present no departmental method of dealing That, in the barest outline, is the Government scheme.

IT is obvious that a step of first-class importance has been taken and that the potentialities for good of the Committee of Imperial Research can scarcely be exaggerated. What has been done and is to be done is something far greater than to add a mere annexe to the structure of the Department of Scientific and Industrial Research. Already, as was pointed out in a leading article in NATURE on November 15, 1924, the work of that department has made a good beginning in the evolution of a national scientific policy. The creation of the Committee of Imperial Research is the first necessary step in the development of an imperial scientific policy—imperial in that it is to take into view the needs of the whole Empire; scientific in its widest sense, embracing, not merely the application of all branches of science, as needed, to the varying problems presented by the different parts of the Empire, but also the methods and outlook of science If from the start the members of this new Committee take a wide view and a far horizon, it may well turn out that more will be done

for imperial unity and imperial development than has been or can be done by the best laid political or military schemes. The announcement of the names of the members of the Committee of Imperial Research will be awaited with anxious interest.

IN the House of Commons on May 15, Mr H Williams asked the Financial Secretary to the Treasury for a statement of the total sum provided for scientific research of all kinds in the estimates for the present financial year. Mr Guinness replied as follows: "Including the cost of buildings maintained by the Office of Works, but exclusive of the cost of administrative staff (except in the case of the Department of Scientific and Industrial Research), it may be stated that a sum of 4,045,000*l* is provided in Estimates 1925-26 for scientific research of all kinds." No doubt this figure is accurate, but unless some indication is given as to what is included by the Treasury under the terms "scientific research of all kinds," Mr. Guinness's answer is liable to give a seriously misleading impression.

LET us turn to the Civil Service Estimates for the year ending March 31, 1926, Class IV. (H.M.S.O., Price 1*s* 6*d* net). There we find under the section devoted to the Department of Scientific and Industrial Research, that the estimate for the year of that Department, including the Geological Survey of Great Britain, the Museum of Geology, and a Grant in Aid, is 380,263*l*. Of this sum, 40,000*l*. is definitely allocated to "Grants for investigation and research." Estimates for the cost of actual research work, exclusive of the Geological Survey side, reach a total of 355,184*l*., and against this is set 117,619*l* as the estimate for Appropriations in Aid, comprised of fees for tests, charges for investigations, sale of maps, of by-products, and so on. These figures cover the work of the National Physical Laboratory, and the official work on building, fuel, and other research. Turning now to the Medical Research Council, another body with which the term "scientific research" is definitely associated, we find that the Grant in Aid of the expenses of the Council is 135,000*l*. Scientific societies, observatories, and so on, account for a further 65,187*l*., though a large part of this cannot obviously be for scientific research as rightly understood. Our total now is well over half a million, but there is a big gap between this and four millions. The Fighting Services expend a considerable amount upon scientific work of various kinds, which is presumably included in this total, but details as to how the sum is made up would be illuminating. Mr. Guinness's reply requires considerable amplification before it can show anything of the real financial position of scientific research in Great Britain.

A DINNER was given at Christ's College, Cambridge, on Saturday, May 23, in celebration of the attainment by Dr. A. C. Haddon of his seventieth birthday, and on the eve of his retirement from the post of reader in anthropology and ethnology in the University. The chair was taken by Sir William Ridgeway. Among the large gathering present were Mrs. Haddon, the Vice-Chancellor (Prof. A. C. Seward), Sir Arthur Shipley, Prof. C. G. Seligman, Mr. H. Balfour, Prof. A. Francis Dixon, Prof. J. Graham Kerr, Prof. Hobson, Dr. C. S. Myers, Prof. Pearson, Mr Martin White, and Mr. P. A. de Laszlo. Eloquent tributes were paid to Dr Haddon's achievements as an anthropologist and as a teacher of anthropology. Sir William Ridgeway said that his researches in the field had made him one of the leading ethnologists of the day with a world-wide reputation. By his zeal and self-sacrifice he had done more than any man to forward the teaching of anthropology in the University. Mr. Balfour referred to his versatility, he had not been a specialist in any one branch, but was master of them all. Prof. Seligman spoke of his success as a leader of expeditions in the field. In replying, Dr. Haddon referred to the unvarying kindness he had met from his colleagues. In reviewing his life, he said his work as professor of zoology at Dublin had led to his expedition to the Torres Straits, where he had got to know the natives and had turned to study them. Though warned by Sir William Flower that there was no money in his studies—a fact he had afterwards verified—he had persevered, lecturing at Cambridge without stipend until his second expedition to the Torres Straits. In the University, anthropology is still going through critical times and the subject is not yet fully established. Portraits of Dr. Haddon have been painted by Mr de Laszlo to perpetuate his work. Of these, one will be hung in Christ's College, another is to be given to the Museum, and the third will be presented by the artist to the family.

THE bird sanctuaries in the Royal Parks in London owe their existence in the first instance to the War, for when the gardeners were away, certain enclosures used by them became overgrown with nettles and brambles. In these several kinds of birds, which on migration usually make but a short stay, found suitable cover and remained to build their nests and rear their young. Mr. Rudge Harding sent a note to the *Field* recording the nesting of the willow warbler and the lesser whitethroat in Hyde Park, and Mr. Harold Russell, who saw this, wrote to the Office of Works and suggested the formation of bird sanctuaries. Lord Crawford, then H.M. First Commissioner of Works, appointed a Bird Sanctuary Committee, with Sir Lionel Earle as chairman, and Mr. E. Batch as secretary, and sanctuaries were made in Hyde Park, Kensington Gardens, St James's Park, and Greenwich Park, in which suitable undergrowth was planted and bird boxes were put up. The experiment continues to be successful. It is on the south side of the bird sanctuary in Hyde Park, which lies just north of the line joining the Superintendent's Lodge and the Powder Magazine, that the memorial to W. H. Hudson has been recently erected. A good many years ago, when Sir Schomberg MacDonnell was the Secretary to the Office of Works, nesting boxes were put up in Hyde Park and Kensington Gardens and Richmond Park at the request of the Selborne Society, which provided the boxes. The results in this case were also satisfactory, and in Richmond Park the first record was obtained of a woodpecker building in a nesting box in Great Britain. In this

park, where there are a heronry and considerable enclosures, the protection of birds has apparently been continued from the time of the first experiment, and received an additional impetus when the other sanctuaries were formed.

THE forthcoming celebration of the centenary of the discovery of benzene (NATURE, May 9, p 685) will, it is hoped, interest and stimulate all who realise the value of science to the community Though most famous as a physicist, Faraday was also a great chemist, moreover, he was a true natural philosopher, taking a wide and impartial view of things, and his character as a man was singularly beautiful. On June 16, 1825, he communicated to the Royal Society a paper entitled "On new compounds of carbon and hydrogen, and on certain other products obtained during the decomposition of oil by heat," in which he described the isolation and the properties of benzene and butylene (called by him, respectively, "bi-carburet of hydrogen" and "new carburet of hydrogen"), and this paper was referred to by Berzelius as incontestably the most important of the year The raw material used was the oil which separated during the storage under pressure of the illuminating gas of that period (made by decomposing fish-oil at a red heat), and the hydrocarbons mentioned were extracted by purely physical processes, namely, fractional distillation and "freezing-out" The benzene obtained was substantially pure, containing 11 576 parts of carbon to 1 of hydrogen, as compared with 12 . 1 required by theory.

GREAT skill and patience were shown by Faraday in the discovery of benzene, but it was left to the future to disclose the great importance of the discovery. Not only has benzene played a leading part in the development of the theoretical foundations of organic chemistry, as a solvent and as a starting-point for the preparation of innumerable organic compounds in the laboratory, but it has become an indispensable raw material of industry It is the parent substance of a host of dyestuffs and medicaments, and it is used in large quantities in the rubber, paint and varnish, vegetable-oil, and motor-fuel industries. As previously announced, the commemoration of the centenary of its discovery will include a reception, lecture, and a dinner. The reception will be held at 11 A.M. in the Royal Institution on June 16, when the following foreign delegates, among others, will be present: Prof. G. Bertrand (Paris), Prof. E. Cohen (Utrecht), Prof. F. Swarts (Ghent), and Prof. J. F. Norris, of the Massachusetts Institute of Technology. Sir William Pope will deliver the lecture at the Institution on Friday evening, June 12, at 9 P.M., on "Faraday as a Chemist." The centenary banquet will take place on the evening of June 16 at the Goldsmiths' Hall Application for tickets of admission and for the banquet (two guineas) should be made to the Secretary, Royal Institution.

A SEVERE earthquake occurred at about 11 A.M. (about 2 A.M., G.M.T.) on May 23 on the north-west side of Japan. The towns most seriously affected are Kumihama, Kinosaki and Toyooka, and, as in 1923, the damage was more due to the subsequent fires than to the shocks A first estimate puts the number of persons killed at 100, and of wounded at 1000, while 10,000 are said to be destitute The railway services were suspended for a few hours, but rescue trains were not delayed The shock was strongly felt at Kobe and Osaka on the opposite side of the island, and it was also perceptible at Kyoto, Okayama, Nagoya and Niigata, but not so far as Tokyo. One of the most interesting features of the earthquake is its occurrence on the Japan Sea side of the islands, which is much less frequently visited than the opposite coast For example, of the ten most extensive and violent earthquakes since the fifth century, three have occurred in central Japan and seven off the south-east coast On the Japan Sea side, during the same interval, five earthquakes were followed by small sea-waves, on the other side, great sea-waves swept in after twenty-three earthquakes. Again, during the years 1885–1905, according to the late Prof Omori, 257 earthquakes disturbed areas of more than 25,000 square miles, and, of these, 145 originated off the east coast, and only 9 off the west side The provinces (Tango and Tajima) chiefly affected by the shock of May 23 seem to have been disturbed by few earthquakes between the years 416 and 1867 In Sekiya's great catalogue, the province of Tajima is only once mentioned (in 1666) as the central district of an earthquake.

ON May 21, 1825, a hundred years ago, the Royal Society of Arts voted its large silver medal and a sum of thirty guineas to William Sturgeon for a number of pieces of apparatus for demonstrating the principles of electromagnetism, which he had presented to the Society. Among this apparatus was a horseshoe magnet made of a piece of round bar iron wound with some eighteen turns of copper wire Sturgeon was the first to make such an electromagnet To mark the hundredth anniversary of the presentation, Prof. J. A Fleming on May 20 delivered a lecture to the Society on "William Sturgeon and the Centenary of the Electromagnet" In the course of the lecture, Prof Fleming gave a few details of Sturgeon and also dealt with modern theories of magnetism and with the various important alloys which have magnetic properties Among these is permalloy, which has very large permeability for very small magnetic forces and is being used for the uniform loading of the latest submarine cables, thus increasing the working capacity enormously. Permalloy consists of 78 5 per cent. nickel and 21 5 per cent. iron, and its preparation was due to the research work of two American companies A section of the new cable is exhibited in the Science Museum, South Kensington. All Sturgeon's original apparatus has unfortunately been lost, but Prof Fleming showed a replica of the electromagnet.

WHETHER we consider Sturgeon's upbringing, his station in life, or the state of scientific teaching at the time, his career was surprising. The son of an ingenious but idle bootmaker, Sturgeon was apprenticed

to a harsh master and then changed the cobbler's bench for the drill ground, passing from the Militia into the Artillery With little help he learnt mathematics, Latin, and Greek, and on Woolwich Common made electrical experiments with kites Leaving the army in 1820 on a pension of a shilling a day, he resumed his cobbling and his scientific experiments, and his merits led to his appointment as lecturer in science at the East India Company's College at Addiscombe He was forty-two when he made his electromagnet Later, he was connected with the Adelaide Gallery of Practical Science in the Strand and with the Victoria Gallery of Science at Manchester, but neither institution flourished, and his last years were spent in poverty He started periodicals and continued to lecture, but found it hard to keep the wolf from the door When sixty-two years of age he was given a small Civil List pension. No man more deserved such help, but he only enjoyed his pension for a short while, for he died in 1850 At the close of the lecture Prof. Fleming suggested that Sturgeon's work might be fittingly commemorated by the Royal Society of Arts by the foundation of a Sturgeon lecture

DR THORNE M CARPENTER, in his discourse on Friday, May 22, at the Royal Institution on the Nutrition Laboratory of the Carnegie Institution of Washington, said that the greater portion of the researches of the Laboratory are conducted with humans, supplemented by studies on other animals. The development of apparatus for the direct measurement of heat elimination and production and for the determination of respiratory exchange has formed an important part of its work Recent apparatus includes a gas analysis apparatus for the exact determination of carbon dioxide and oxygen in atmospheric and room air, and a modification of the simplest form of respiratory exchange apparatus so that the indirect determination of the heat of combustion or energy value of foods can be estimated indirectly by the measurement of the oxygen used in the combustion A comparison of measurements of heat elimination and production by the direct method (calorimetry) and by the indirect method (respiratory exchange) has shown that the indirect method is the most practicable for the determination of basal metabolism. The observations on humans made by Prof Francis G Benedict, the Director, and his collaborators have resulted in establishing standards by means of which the normal basal heat production of humans from birth to old age can be predicted. These standards include factors for weight, height, age and sex, and their application in clinical medicine to diagnosis and the effect of treatment, illustrates how a purely abstract scientific study proves of practical value. Examples of recent special researches are the determination of the neuromuscular effect of ethyl alcohol correlated with concentration of alcohol in blood and urine, the metabolism of alcohol, lævulose, and dextrose when injected rectally, and the metabolism of steers, together with the composition of their excreta, as affected by prolonged fasting.

DR. J. S BOLTON, professor of mental diseases in the University of Leeds, delivered the Maudsley Lecture before the Medico-Psychological Association of Great Britain and Ireland on Thursday, May 21, taking as his subject "Mind and Brain." In the first part of his address, Prof Bolton discussed the evidence for the possession of mind by the lower animals, and criticised very severely the "anthropisation" of insects and birds. He declared that they obey instincts blindly and that their seeming wisdom is a mere illusion. Purposive action begins to appear with the mammals, but even among humans, intelligence is still in a very primitive state "Fortunately for us, our recent origin, and the highly plastic state of our constituent parts which we inherit from our pre-human mammalian ancestry, will in the long run prove our salvation by enabling us rapidly to evolve from our present relatively infantile stage of mental development" In Prof Bolton's opinion, "personality is the intellectual element of mind or cerebral function which exists in inverse proportion to the instinctive element common to mammals and to animals below them." The purpose of education is to replace instinctive reaction to environment by reasoned action, and that this end is not always achieved "is no reason for the retrograde enthroning of the basal instincts which serves as the foundation stone of Freudian psychology" Prof Bolton later referred to what he termed "the myth of the unconscious mind," a conception based on Freud's theory of dream-interpretation If it exists, it must be fully formed before even the necessary brain structure for such functions evolves. Prof. Bolton finds it impossible to frame a definition of the unconscious mind which is consistent with the theories of mind and brain he upholds.

ON Thursday, May 21, Capt Amundsen set out on his flight to the North Pole from King's Bay, Spitsbergen He proposed to journey along the coast for an hour and then, provided the two "flying-boats" were behaving satisfactorily, he would turn directly to the Pole It was thought that the actual flight to the Pole would take seven or eight hours, and if the weather conditions were suitable, a stay of twenty-four hours would be made at the Pole for the purpose of making observations Amundsen was thus due back during Saturday, but at the time of going to press, no news had been received of him. Fine weather appears to have prevailed over the Polar basin during the week-end, but it is feared that the good spell was breaking up Capt. Amundsen is using two Dornier "Wal" flying boats and is accompanied by Mr. L Ellsworth, Lieut. Dietrichsen (in charge of the second machine), Lieut. Riiser-Larsen, and Lieut Omdhal. Both machines are carrying complete equipment, so that in the event of a breakdown, the party will be able to make its way on foot back to the base

ON behalf of the Field Museum of Natural History, Chicago, Colonel Theodore Roosevelt, junr., and Mr. Kermit Roosevelt are leading an expedition, in other respects financed by Mr. James Simpson, through

central and southern Asia. Entering India at Bombay, the expedition will proceed to Srinagar in Kashmir. Thence crossing the Himalayas by way of Leh and the Karakoram Pass, it will make excursions into the Pamir region and then cross Turkestan to the Thian Shan Mountains. The duration and subsequent course of the expedition will depend on circumstances. The main object of the expedition is to obtain animals of different ages and sexes required for large habitat groups in the Field Museum, but no doubt collections will also be made with a more purely scientific object It is intended, for example, to collect reptiles, amphibians, and freshwater fishes. Mr. George K. Cherrie will accompany the expedition from the United States, but other trained zoological collectors will be engaged in England or in India.

THE annual visitation of the Royal Observatory, Greenwich, will take place on Saturday, June 6. The Observatory will be open for inspection at 3 P.M.

PROF. W. MAGNUS, of Utrecht, will deliver the Croonian Lecture of the Royal Society on June 11, taking as his subject "Animal Posture"

MR. T. SHEPPARD, the curator of the museums at Hull, has received an intimation from Mr J Digby Firth, president of the Leeds Co-operative Field Naturalists' Club, one of the oldest field clubs in Yorkshire, that he has been elected an honorary life member in appreciation of the valuable work he has done and is doing to the cause of science, particularly in the north of England.

IN reply to a question in the House of Commons on May 25, Mr Baldwin said: "In view of the decision to hold a general inquiry into the broadcasting system towards the close of the year, the Government have decided not to proceed this session with the Wireless Telegraphy and Signalling Bill. A short Bill will be introduced instead, with the single object of resolving any doubt as to the validity of the existing licence system."

DR. N. L. BRITTON, emeritus professor of botany in Columbia University and Director-in-Chief of the New York Botanic Garden; Prof. G. H. Parker, professor of zoology in Harvard University; Prof. F. Raffaele, professor of zoology in the Royal University of Rome; Prof. C. Shröter, professor of botany in the Federal Polytechnic, Zürich; and A. Zahlbruckner, of the botanical department of the State Natural History Museum, Vienna, have been elected foreign members of the Linnean Society of London.

THE following have been elected foreign members of the National Academy of Sciences, Washington, D.C.: The Hon. Sir Charles Parsons; Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge; Dr. Adolph Engler, professor of botany in the University of Berlin; Dr. Niels Bohr, professor of physics in the University of Copenhagen; M. Charles P. E. Schneider, a distinguished French engineer; Dr. Hans Speman, professor of zoology, University of Freiburg i. Br.

THE Pontificia Accademia Delle Scienze Nuovi Lincei at Rome organised this year, as two years ago, an "Academy Week" of lectures by members of the Academy, as part of a scheme for the spread of knowledge among scientific workers. The lectures were given in the historic halls of the Palazzo della Cancelleria and were much appreciated by the members of the University and the public. The following topics were discussed: History of mathematics (Prof Gomes Teixeira, University of Oporto); aerodynamics and aeronautical constructions (Prof. Panetti, Royal Polytechnic School of Turin), graphic calculation and mechanical calculation (Prof M d'Ocagne, free academician of the Paris Academy of Sciences; geophysics (P. Algué, Director of the Central Observatory of the Philippine Islands), our knowledge of the ultra-microbes (Prof Caronia, Director of the Clinical Surgery of the University of Rome) The lectures will be published in the Atti of the Papal Academy.

THE second Indian Plant Breeders' Conference was held at Surat on February 26-28, under the chairmanship of Mr R K Bhide, Crop Botanist of the Bombay Presidency The mere fact that such a conference, attended as it was by a dozen specialists and about twenty others, should be held in India, shows how rapidly that country is now moving along the path of scientific progress. Among the subjects discussed were probable error in field experiments, the problems of sterility and fertilisation, acclimatisation, stability of the performance of improved varieties, and standardisation of testing methods. The general opinion with regard to improved varieties was that they retain their superiority even under the conditions supplied by the ordinary cultivator The Conference thought it desirable that the Director of Agriculture should get someone on the staff of his Department to specialise in biomathematics, to give lectures to men taking up plant breeding, and so to assist the plant breeders in interpreting their results

THE National Physical Laboratory is distributing free copies of a useful pamphlet on the testing of weights and balances It contains information on the conditions which weights intended for accurate work should satisfy, and describes a new form of certificate on a "weight in air" basis, which will secure an accuracy in weighing of one part in a million, in terms of either the International kilogram or of the Imperial standard pound. Balances are also tested as to general functioning and sensitiveness under various loads, and specific gravity balances of the sinker weighing type to an accuracy of one part in a thousand or in three thousand. Tables of fees for the various types of test are given

IN a paper read to the Society of Engineers on May 4, R. C. S. Walters described some of the water-power exhibits at the British Empire Exhibition at Wembley in 1924 and gave some interesting data An estimate is made of the fraction of their total water-power resources that several of the dominions have developed Canada, which has immense resources, utilises 8 per cent. of them; Newfoundland, 30 per cent.; New Zealand (North), 20 per cent.;

New Zealand (South), 2 per cent ; Tasmania, 12 per cent.; and Ceylon, 3·5 per cent A large part of this work has been done since the War and further large developments are in progress Many British firms are specialising on hydro-electric equipment so as to be ready to meet the increased demand for this type of machinery In Newfoundland there is a large water-power scheme in progress capable of being developed to 250,000 H P., for the manufacture of paper. A hundred horse-power for a day is required to manufacture a ton of paper. At the Exhibition, impulse turbines capable of giving 60,000 H P. were shown.

We have received from the Canadian Department of Mines a copy of pamphlet No 618 on " Fuels and Fuel Testing " The contents consist of six contributions to the subject , the carbonisation of lignite and sub-bituminous coals, survey of Maritime Provinces coals, nature of sulphur in coal and coke from the Maritime Provinces, gasoline survey (1923), the Hartman oil shale retort, and a report on the Ramage process for oil refining.

Catalogue No 12, 1925, of " Old Books and MSS " just issued by W H Robinson, 4 Nelson Street, Newcastle-upon-Tyne, is worth obtaining by readers interested in early editions Among the sections are Old Scientific Books, Voyages and Travels, and Medicine. Many of the works listed are very rare

Dr. Silberstfin referred in his letter published in last week's Nature, p 798, to " a *Phil Mag* paper (1919) " Sir Oliver Lodge has been kind enough to send us the exact reference, namely, *Phil. Mag.*, February 1920, vol 39, p 161. He himself communicated the paper to the *Phil Mag*

Lieut.-Col. E. Gold informs us that the name of Capt. Wehrlé was inadvertantly omitted from the list of members of the sub-commission on balloons in the draft minutes of the meeting, and also from the list appearing in Nature of May 16, p. 782, col. 2, in Lieut -Col. Gold's article on the International Commission for the Investigation of the Upper Air.

Applications are invited for the following appointments, on or before the dates mentioned :—Head of the Electrical Engineering Department of Rutherford Technical College, Newcastle-upon-Tyne—Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (June 8). A full-time lecturer in mathematics at the Wigan and District Mining and Technical College — The Principal, Library Street, Wigan (June 8). An assistant lecturer in mathematics and an assistant lecturer in geography in the University of Bristol—The Registrar (June 10). An assistant lecturer in biology at King's College for Women (Household and Social Science Department)—The Secretary, Campden Hill Road, W. 8 (June 12). A responsible science mistress (physics and chemistry) at the County School for Girls, Chatham—The Headmistress The University professorship of geography at the London School of Economics—The Academic Registrar, University of London, South Kensington, S.W.7 (June 18). An assistant chemist in the Government Laboratories, Federated Malay States — The Private Secretary (Appointments), Colonial Office, Downing Street, S W 1 (June 30). An assistant Government chemist, Zanzibar—The Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1 (June 30).

Our Astronomical Column.

Researches on Cepheids in Spiral Nebulæ — The May issue of the *Observatory* contains an interesting summary of Prof. Hubble's paper describing his researches One is filled with admiration for the skill which must be required in determining periods and approximate light curves of some 80 objects, which at their brightest are fainter than mag. 18, and in many cases are too faint at minimum to appear on the plates Enough of the light curve has to be traced to determine that the type of variation is Cepheid, since Shapley's relation between absolute magnitude and period applies to these alone. The periods vary from 17 days to 50 days, the corresponding maximum magnitudes being 19 0 and 18 4, on plotting log P and maximum magnitude, a good agreement is found with Shapley's law, the average deviation in M 33 being 0·1 magnitude.

As a proof that the Cepheids are really in the spiral nebulæ and not merely projected upon them, considerable areas in the neighbouring sky were explored, without finding any Cepheids.

The presence of perceptible absorption of light by nebulous matter is rendered improbable by the fact that the Cepheids are scattered over large regions of the spirals, and all give fairly accordant values of the distance, which comes out as 285,000 parsecs or 930,000 light years for both M 31 and M 33. Variables have also been found in M 81, M 101 and N.G.C. 2403.

Comets —Dr. W. H Steavenson found Orkisz's Comet still very conspicuous on May 20. It was easily visible in a small hand telescope, and at least of magnitude 7 5. A tendency to tail formation was noticed in P.A. 250°.

Ephemeris of Orkisz's Comet for 0h.

	R A	N. Decl.
May 27.	2h 10m 57s	80° 19′
June 4.	6 13 29	81 43
12	8 31 18	76 45
20.	9 24 13	70 58

Dr. Steavenson also observed Schain's Comet as follows

G.M.T.	R.A. 1925·0	N. Decl. 1925·0
May 10d 21h 51 9m	10h 36m 24·82s	4° 23′ 13·5″
12 21 53 6	10 34 29 60	4 25 14·3
20 22 22·0	10 27 40·20	4 28 53·7

From the first two observations, Mr. G. Merton has corrected the orbit as follows :

T	1925 Sept. 4·5379 G.M T.
ω	205° 19·14′
Ω	357 29 66
i	146 43 12
log q	0 62196

Ephemeris of Schain's Comet for 0h.

	R.A.	N. Decl.
May 26.	10h 24m 14s	4° 29′
30.	10 21 47	4 27
June 3.	10 19 36	4 24
7.	10 17 46	4 19
11.	10 16 11	4 14
15.	10 14 52	4 7

Research Items.

AN EGYPTIAN SURVIVAL.—In *Man* for May, Miss Winifred Blackman suggests an explanation, based on a modern custom, of the purpose of the clay balls found by Prof. Peet at Abydos, by Sir Flinders Petrie at Kahun, and by Prof Garstang at Reqaqna. When those from Abydos were cut open, two were found to contain fragments of reed and one a square bit of linen cloth. Two from Kahun, when examined in 1916 by the Manchester Museum authorities, were found to contain a tuft of red-brown human hair, apparently infantile. These belonged to the XXth dynasty, while those found by Prof. Peet dated from the Old Kingdom. Further, in the Egypt Exploration Society's account of its excavations in 1921 and 1922, "The City of Akhnenaten," Pt. I., p. 66, it is stated that a common object among the finds was a small ball of mud, sometimes stamped with impressions of signet rings, containing a wisp of hair. In the course of researches among the *Fellahin* of Upper Egypt, Miss Blackman found that it is a custom for boys, both Kopts and Moslem, to undergo a ceremonial shaving of the tufts of hair which it is customary to leave on their shaven heads. This operation is performed either at the tomb of a sheikh, or a church if the boy is a Kopt, and the tufts are dedicated to the sheikh or a saint as the case may be. The ceremony is accompanied by a feast. The hair cut off is always buried outside the tomb or mosque, either loose or enclosed in a clay ball A small piece of the dress of a devotee is sometimes suspended from cords hanging over the catafalque of a sheikh. The pieces of linen found in the clay balls may represent a similar votive offering.

INDUSTRIAL FATIGUE.—The Harveian Lecture on "Industrial Fatigue," given on April 23 by Dr C S. Myers, appears in the *Lancet* of May 2 Dr Myers reviews the earliest work on fatigue problems, showing that the tests used, whether of efficiency or fatiguability, while interesting in themselves, were chiefly valuable in revealing the complicated nature of fatigue. When an application to industry is required, the theoretical studies of muscular metabolism or of the central nervous system fail to throw light on the output variations of the worker. In recent investigations industrial fatigue has been measured by its direct effects in output. Curves of total output and curves of spoilt work are studied; alterations in the environment are made and the effect of these on the work curve noted. By such means it has been possible to show the effect of improvements in lighting, ventilation, posture, arrangement of time, etc. Diminution in output may result not only from fatigue but also from lack of incentive or boredom or worry. In the majority of cases under present-day conditions, industrial fatigue is not to be reduced by shortening the hours of work but by the avoidance of too long uninterrupted spells of work, by the introduction of rest pauses, by adequate training of the worker, by the abolition of causes of needless resentment, irritation, and worry, etc. Industrial fatigue is too complex, and our knowledge of the physiology of the nervous system too rudimentary, to allow of a definition in physical and chemical terms.

THE VINE IN VICTORIA.—In "Problems of the Viticultural Industry" A. V. Lyon has collected in small compass much information with regard to the Australian industry in the irrigated lands of the Murray Valley of Victoria. The more important scientific and technical aspects are set forth, with the results of the research work carried out during the last four years by various bodies of workers. The processes and problems appertaining to viticulture are dealt with systematically from the establishment of a vineyard onwards, the whole scheme being clearly set out in a detailed table of contents. The points dealt with include the pruning and training of the vine, irrigation, drainage and manuring, fruit drying and the seasonal and routine work in the vineyards. A considerable section of the bulletin is devoted to a survey of the fungus and insect pests of the vine, suggestions for treatment and eradication being made in each case. Black spot (*Mangimia ampelina*), downy mildew (*Plasmopara viticola*), and oidium (*Uncinula spiralis*) are the most serious fungus diseases, and phylloxera and the lesser dried fruit-moth (*Plodia interpunctella*) are the two insects that cause most concern in the Australian viticultural industry. The bulletin concludes with a review of various problems of general interest, including increase in production, cost of production, irrigation, plant breeding and selection, and pruning, on all of which further research is desirable, as investigations are not at present proceeding at a rate commensurable with the importance of the industry

ORIGINS OF UNDERGROUND WATERS.—Volume 28 of the Bulletin of the Adriatic Society of Natural Sciences (Trieste) contains an interesting and very complete account, by Prof Guido Timeus, of the various physical, chemical, and biological methods which have been suggested for the investigation of the origins, courses, etc., of underground waters Full details are given of each method, including the fluorescein method of Prof. Timeus himself, and a description is included of a new procedure which, by the dyeing of strands of de-fatted wool, permits of the certain detection of 10^{-7} milligram of the colouring matter.

CARBONIFEROUS GONIATITES.—The zonal characters and distribution of the Carboniferous goniatites of the north of England have been worked out in detail by W. S. Bisat (Proc Yorks Geol Soc, 20, Part 1, 1924, p 40, pls. 1-x) In this region goniatites appear first in the upper part of the Lower Carboniferous (Visean), and continue through the Millstone Grit into the Lower Coal Measures, the main divisions of these beds are characterised by the appearance in succession of the genera Prolecanites, Goniatites (s. str.), Eumorphoceras, Homoceras, Reticuloceras, Gastrioceras A full account is given of the species found, illustrated by collotype reproductions of photographs.

RADIOACTIVITY AND GEOLOGY.—In the Halley Lecture delivered last year, and now published by the Oxford University Press, Prof. J Joly has summarised his views on "Radioactivity and the Surface History of the Earth." He shows that if the basaltic layer which forms the ocean floor and underlies the continents is as rich in the radioactive elements as those specimens of it which are available for study, then it must, in the course of some 30 million years, become fused at and below a certain depth. At the present time it is mainly solid, but beneath the continents and under the ocean floor the temperature must be nearly that of liquefaction, so that in time the accumulating radioactive heat will supply the latent heat necessary to change its state. It is supposed that in early Tertiary times widespread liquefaction due to this cause actually occurred. The resulting increase of volume caused the continents to be thrown into a state of tension, while the decreased density of the magma allowed the continents

to sink relatively to the oceans. Tidal forces were meanwhile acting on the crust, causing it to drift to the west in opposition to the direction of the earth's rotation. Specially hot magma from beneath the continents thus came to underlie the oceans to the east, and melting of the ocean floor would then occur until the loss of heat into the ocean itself was sufficiently rapid to bring the process to an end and permit recrystallisation to begin. As solidification would effectively proceed from beneath upwards, the continents would gradually be grounded on a more resistant foundation of newly made rocks and brought to a standstill. The decrease of volume attending this part of the cycle would promote severe compression on the continental margins, and corresponding to the deduction we find the mountains of Eurasia beginning to rise from the Miocene onwards. The latent-heat cycle thus comes to a close at about the present time, leaving the continents at a relatively high level and the interior effectively solid.

VELOCITY OF UPPER AIR.—The Meteorological Office, Air Ministry, gives a discussion of "The measurement of upper air wind velocities by observations of artificial clouds," by Mr. C. D. Stewart, in Prof. Notes, Vol. 3, No. 38 (H.M. Stationery Office. Price 9*d*.) The motion of clouds forms an important part of meteorological work, and the observations are of considerable use for forecasting and other branches of the science. During the War much attention was given to the movement of the upper air in relation to the firing of big guns, but for a time afterwards the observations fell into disuse. The inquiry has now received a fresh impetus, and the present discussion gives details to facilitate the necessary calculations. The principle of the mirror nephoscope is the method used for obtaining velocities of both natural and artificial clouds. For ordinary clouds two horizontal mirrors suitably mounted are used, but for artificial clouds where the height is known, one mirror only is required for the determination of their velocity. The method was originally used for clouds formed by the bursting of shells, but observations have recently been made on clouds liberated from aeroplanes. A tin is filled with stannic chloride, which when mixed with the air forms a dense white cloud. The tin or canister is opened and the liquid is ejected by a simple device which results in the formation of a cloud which lasts for about a quarter of an hour. Observations are believed to be effective to at least the height of 3 miles. The discussion contains diagrams of the Hill mirror and the method of observing.

THE FORCES CONCERNED IN NUCLEAR COLLISIONS.—In their paper in the *Physikalische Zeitschrift* of November 15, 1924, Drs. H. Pettersson and G. Kirsch mention that they have obtained some evidence which tends to show that, in the case of aluminium, a colliding α-particle may unite with the nucleus of the metallic atom, the collision being inelastic. In a paper in the *Arkiv för Matematik Astronomi och Fysik*, communicated January 14, Dr. Pettersson considers the satellite hypothesis of Rutherford and Chadwick, which supposes that the proton liberated by bombardment with an α-particle existed in the nucleus as a kind of planet, revolving round the core at some distance from the centre. This implies attraction between like electrified particles at very small distances. Dr. Pettersson thinks that it may not be necessary to assume any such reversal of Coulomb's law, either to explain the constitution of the nucleus or the behaviour of the colliding α-particle, and directs attention to the fact that a charged particle, brought very near to the surface of a conducting sphere having a charge of the same sign, is *attracted* by it owing to electrostatic induction. A displacement of the protons and electrons in the nucleus may take place in a similar manner when the α-particle gets very close to it, and the force acting on the α-particle may become attractive. At the same time, the resultant force on a proton at the opposite side of the nucleus due to the other protons, the electrons and the α-particle may become repulsive, and it will leave the atom.

THE FLUORESCENCE OF DYE STUFFS IN CONCENTRATED SOLUTIONS.—It has been shown by Dr. S. J. Wawilow that the fluorescent output of dilute solutions can attain very large absolute values. In the *Zeitschrift für Physik*, March 21, he describes an investigation of the phenomenon observed by Stokes, who found that at high concentrations the fluorescent output was greatly diminished. The distribution curve for the energy of fluorescence was practically unchanged when the concentration was altered, which enabled a simple method of measurement to be used. In the cases examined extinction was observed to commence at a definite concentration C_0, proceeding from that point according to an exponential law which holds until the fluorescent output is very small, when it begins to fall off more rapidly. The curves of extinction and of electrical conductivity of the same solution show no parallelism, which is against any electrolytic explanation of extinction. It is explained provisionally by regarding the heavy molecules as subjected to Brownian movements, and supposing that, when two such molecules collide, one of which is excited, the energy of excitation may be transferred to the other molecule as kinetic energy, no radiation being given off. The theory is worked out in some detail.

PURE METHYL ALCOHOL.—The preparation of pure methyl alcohol is described by H. Hartley and H. R. Raikes in the March issue of the Journal of the Chemical Society. The alcohol is dehydrated by fractionating in Hempel columns until its boiling point is constant to within 0·05°. It is then refractionated once more, refluxed with aluminium amalgam (3 gm. per litre), and finally distilled at the rate of two drops a second, the first 50 c.c. and the final quarter being rejected. If required for electrochemical work, the alcohol is further fractionated and distilled over copper sulphate, a tin condenser being used. Alcohol with a conductivity of $0{\cdot}04 \times 10^{-6}$ r.o. was readily obtained in this way. An improved method of determining the water in methyl alcohol is described.

ALKALI-CHLORINE PRODUCTS.—An illustrated article in *Chemistry and Industry* for February 27 and March 6, by D. A. Pritchard and G. E. Gollop, describes the Canadian Salt Company's processes for the manufacture of alkali-chlorine products. Saturated brine is pumped from the wells and purified from magnesium and lime salts by the addition of the calculated quantity of sodium carbonate solution containing a trace of caustic soda, at 85°. The mother liquor is decanted off and fed, at 85°, into electrolytic cells of the Gibbs' type, where it is converted into caustic soda (120 gm. per litre) and chlorine (95 per cent.). The working-up of these products is described in considerable detail. The chlorine is liquefied by the tower system. The gas is passed up through a spray of strong sulphuric acid in a tower; it is then dry enough to be liquefied in iron plant. The manufacture of bleaching powder is also carried out by this company; the methods used, together with recent improvements, are given in full.

Modern Investigations of Mental Imagery.[1]

By Prof. T H PEAR.

IT is necessary to distinguish at the outset between several types of revived experience. First there is the *after-sensation* (sometimes called the after-image), which is probably not revived at all but a persistence of the effect of the original stimulus In vision this phenomenon is familiar to us as the positive after-sensation which reproduces the colour and brightness of the original stimulus, and the negative after-sensation in which the colour and brightness are complementary to those of the stimulus Equally well-known phenomena are the memory images proper; those revivals of experience which may occur in the form of visual, auditory and other images; in fact there are probably as many types of such imagery as there are types of sensation

Intermediate between these is the type of image which is the subject of this paper In the last century it was described by Fechner and called by him the *memory after-image* Until recently it has been called either by this name or the *primary memory image*. Only lately, however, has it been specially studied and in rather special circumstances.

These studies have been chiefly carried on at Marburg under the direction of C. R. Jaensch. These researches claim to have found certain unique and hitherto unrecognised characteristics of imagery in children. Some of the work has been repeated and the conclusions carefully checked by G W Allport of Cambridge From his article on "Eidetic Imagery" (*British Journal of Psychology*, 15, 1924, 99-120) much of the present summary has been taken

The modern investigators call the image which they are describing an "eidetic image" It differs from an ordinary visual memory image in many ways Most common among these is that while in the case of a visual image a former visual perception is merely imagined, in the eidetic image the original object is actually "seen" projected in space. It can be seen particularly well when the eyes are closed in a dark room.

Results show that approximately 60 per cent. of all children between the ages of 10 and 15 are able to produce eidetic images. During adolescence this ability retreats. There seems, however, a considerable probability that a large number of poets and artists are in this respect "grown-up children." If this be true, it explains several puzzling points in connexion with poets' and artists' description of their own imagery.

Characteristics of the eidetic image may be summarised thus:

It is literally and truly "seen."

Attention when observing it is directed outwards.

It is usually localised against any background and is never entirely unlocalised.

Though possessed of an outer character like a true perception, it is always recognised as a distinctly subjective phenomenon. It differs both from the memory image and the after-image by its extraordinary richness in detail. This richness in detail is much less dependent upon the structuration in its contents. (The structuration is observable in an ordinary memory image, when a detail particularly interesting to the observer, acting as a nucleus, tends to collect around itself characteristics depending upon it.) In the eidetic image details are frequently observed which do not appear to have this dependence upon the observer's interest Children have reported details with extraordinary fidelity, *e.g.* the length and direction of the lines of shading in a stretch of roadway, details unrelated to any "nucleus" in the original picture.

The eidetic image is unusually persistent and often returns. When it does return its details are often extraordinarily accurate. It may be that the so-called hypnagogic images which appear to many normal people just before falling asleep are of the eidetic type But apparently the exclusion of borderline and pathological phenomena from this conception of the eidetic image makes it impossible at present to discuss this connexion

There appears to be little doubt of the importance of the study of this eidetic image both for an understanding of the mentality of the developing individual and for a better comprehension of certain questions connected with literature and art. In the realm of applied art it is not impossible that a knowledge of this type of imagery and its occurrence among adults might be of use in the work of the poster artist. For many posters are seen while the observer is in motion, and their details, therefore, are possibly apprehended after the poster has disappeared from the visual field.

The relation of this work to psychopathology, more particularly to the question of pseudo-hallucinations and the type of mentality subject to them, is of the first importance

[1] Summary of paper read before the Manchester Literary and Philosophical Society, April 28

Periodicity in Weather and Solar Phenomena.[1]

ALMOST any series of numbers when plotted shows indications of more or less regular sequences; meteorological statistics are no exception to this rule. These recurrences can be investigated by some method of periodogram analysis, and the result is a periodicity or cycle. There exist, however, certain mathematical criteria which can be applied to the results, and when this is done, it is found that the greater number of meteorological periodicities either vanish or at least become highly suspect. According to orthodox views, a cycle should remain constant in length; if it breaks down for a time, it should reappear at the correct phase, and meteorological periodicities do not often behave in the orthodox fashion. Even solar periodicities suffer from this defect, the well-known eleven-year sunspot cycle undergoing marked variations in length.

Mr. H. W. Clough attempts to get over the difficulty by considering the wave-length of a periodicity as itself a periodic function. In 1905 he found that the length of the sunspot cycle has a periodicity of about 36 years, the "Brückner cycle"; this 36-year periodicity, however, is itself not constant, its length varying during a longer cycle, estimated at 300 years He has now investigated a shorter periodicity in sunspots, pressure and temperature, to which various investigators have assigned lengths ranging from 2·5 to 3·5 years, and he finds that it behaves in the same way, its length averaging 2·33 years and varying from 1·5 to 3·5 years according to its position both in the 11-year cycle and in the 36-year cycle The material which he employs consists of composite series of temperature (1730-1924) and pressure (1743-1924) in

[1] "A Systematically Varying Period with an Average Length of 28 Months in Weather and Solar Phenomena." Washington, *Monthly Weather Review*, vol. 52, 1924, pp. 421-445.

Europe, temperature in the United States from 1780 and sunspots from 1750. From the monthly data, two 12-month means per year were formed, one centred on January 1 and the other on July 1. These means were plotted and the maxima and minima were picked out from the graphs. They were also studied statistically in various ways, and the first conclusion was reached, that there is real evidence for the recurrence of maxima and minima at an average interval of about 2 5 years.

The strongest part of this evidence is provided by the method of correlation, or rather of contingency, since the coefficients are calculated from the signs of the variations only, irrespective of their magnitude These coefficients are theoretically the same as those calculated by the full method of correlation, but there is a larger possibility of error due to small accidental variations, and it would have been better to have adopted the full method . Each set of data was correlated with the same data 6, 12, 18, etc , months later, and the coefficients showed maxima after 2 5, 5 and 7 5 to 8 years, with intervening minima , this is clear evidence of the existence of a periodicity of about 2 5 years, and is far more convincing than the periods which are derived graphically

This point being established, the lengths of successive intervals between maxima and between minima were regarded as "observations," and themselves examined for periodicity It is shown that the average difference between the lengths of successive intervals is significantly less than would be expected on the basis of a chance distribution, indicating a tendency towards grouping, and other statistical evidence to the same effect is found. The lengths of the intervals were accordingly plotted and smooth curves were drawn showing the variations of length with time , these indicated that the intervals between epochs are generally least near the rainfall maxima of the Brückner cycle. The origin of these variable meteorological cycles is sought in solar conditions, especially in a 2 5-year period in the mean latitude of sunspots, which also varies in length according to its position in the eleven-year sunspot cycle and in the Brückner cycle. The author derives this period graphically (though to the present writer the graph is more bewildering than convincing), and he considers that the epochs of sunspot latitude fit in well with those of temperature in the United States.

Prof. C. F. Marvin, in a critical discussion, appears to accept the results as sound, and at first sight they appear to be so. Further consideration shows certain objections, which may or may not be valid. The graphical method leaves a certain amount to the judgment of the investigator, and however conscientiously the work may be carried out, there is always a danger that personal bias will weight the result. The method as adopted is unsound for another reason, since the combination of two simple periods of the same amplitude, treated by Clough's method, may also give the appearance of a single period which varies in length systematically. The second difficulty concerns the validity of the data. Both in Europe and the United States the length of the temperature cycle shows a secular increase from nearly two years to more than 2 5 years. This may be real, but it is what one would expect from a progressive increase in the trustworthiness of the data as the stations became more numerous and the observations better.

The author does not give his original data for Europe and North America, so that his conclusions cannot be checked directly. In a later table he gives epochs of maximum and minimum pressure at Batavia, which indicate a variable cycle with an average length of 2 6 years C. Braak found a pressure cycle at Batavia which runs its course in three or occasionally four years, resulting in a "periodicity" of slightly more than three years. The present writer investigated the Batavia pressures by ordinary harmonic analysis and by the "difference-periodogram"; both methods gave a periodicity of 3·15 years, and he could find no trace of a 2 6-year cycle. This result throws doubt on the corresponding periods for Europe and North America.

To sum up, we know that there are frequent examples of recurrence in meteorological phenomena which suggest relationship to solar cycles, but when they are submitted to exact mathematical analysis, the results are usually negative. We infer that either the phenomena are not real, or their true nature is complex. H. W. Clough adopts the latter view, but the solution which he puts forward is not very plausible, and he does not go far enough towards proving it C. E. P. B.

The Tactile Sensory Reflex.

THE investigation of the physiology of the special senses is fraught with difficulties which do not obtrude themselves to the same extent in the case of the other systems of the body. Whereas in the latter the end result of a stimulus is some objective phenomenon, possibly accompanied by a sensation, in the case of the special senses, the subjective sensation is the main effect produced by the stimulation and the accurate description of his sensations by the subject of an experiment requires both training and intelligence, if fallacies are to be avoided The method of investigation also is not without importance, and should be capable of producing stimuli of known force if any accurate comparison between the degree of stimulation and the resulting sensation is to be obtained.

The method of investigating the sensation of touch by means of hairs of varying degrees of stiffness, while giving information as to the spots in a given area sensitive to this form of stimulation, is unsatisfactory, since it is difficult to estimate the actual degree of force applied. F. Allen and A. Hollenberg (*Quart. J. Exp. Physiol.*, 1924, vol. 14, p. 351) have applied a method used in investigations on visual and auditory sensations, to the elucidation of further facts relating to the tactile sensation. A blast of air at a known pressure is interrupted by means of a rotating disc with openings in it and the resulting puffs directed upon the area in which the sense of touch is to be examined, *e.g.* the palmar surface of the tip of the forefinger. Just as in the case of light, the puffs of air will be fused into a single sensation at a certain rate, which may be described as the critical frequency of percussion. Experiment has shown that there are *two* fusion points at any given pressure of the air pulsations up to a pressure of about 5·0 cm. of mercury, at which these two points coincide. It is possible that they represent the superficial and deep tactile sensations respectively. The duration of the stimulation at the critical frequency was found to be related to the pressure by the formula $D = -K \log P + C$, where D is the duration of the stimulus, P the pressure, and K and C constants. The minus sign shows that the critical frequency has a higher value, that is, the duration of the stimulus becomes shorter as the pressure rises.

It is of great interest to note that similar expressions relate the duration and intensity of stimulation in the case of both light and sound, when interrupted stimuli are used. The constants are different for the

two fusion points and vary also according to the sensitiveness of the skin; thus a dry skin is less sensitive than one kept moist and supple by a thin film of vaseline. Moreover, although the curves obtained by plotting D against log P are straight lines, they show a change of slope at a certain value of P, in an opposite direction in the case of the two fusion points, so that they finally intersect. This change of slope occurs also with visual and auditory sensations. As might be expected, fatigue decreases sensitiveness, raising the value of D for a given P.

Perhaps the most important point, however, which emerges from this research is the discovery of the opposite process—an enhancement of the tactile sensation, either by fatigue of an adjacent area, or by very light previous stimulation of the actual area under study; it is seen also in a fatigued area when the fatigue has passed off. The process appears to be a reflex effect through the central nervous system; and its existence gives an explanation of the phenomena of itching and tickling. In the former case, scratching relieves the itching, but adjacent areas become more sensitive and the process is transferred to them: this, together with the subsidence of its own fatigue, causes enhancement of the sensitiveness of the original area, and so a vicious circle is set up; in the latter case, the effect is probably due to an enhancement of sensitiveness by means of a light stimulus: a stronger stimulus fails to arouse it The critical frequency is highest in the case of the tactile sensation, but the actual energy necessary to stimulate is greatest for this sense, being least in the case of light. Thus the effect produced by any tactile stimulus is the resultant of the two processes, a direct fatigue of the area stimulated and the reflex enhancement of its sensitiveness: the latter is only visible if the stimulus is so light that fatigue does not occur, or if time is allowed for the fatigue produced to pass away.

The Liming and Chalking of Soils.

THE second of a series of conferences arranged by the Rothamsted Experimental Station was held on Friday, May 22, when the subject discussed was the liming and chalking of land. Prof. H. E. Armstrong, vice-chairman of the Lawes Agricultural Trust, presided over a gathering of about sixty people, including landowners, farmers, county advisors and organisers, and representatives of firms interested in the supply of chalk and lime.

The morning session was occupied with papers by Dr. J. A. Voelcker, Dr. J. A. Hanley and Mr. E M Crowther. Dr. Voelcker dealt with his pot and field experiments at Woburn, the results of which indicate that lime exercises more benefit than the equivalent quantity of chalk. (A full account of these experiments will shortly be published in the Report of the Woburn Experimental Farm for 1923–24.) Dr. Hanley described the striking effect of applications of chalk on the acid areas of Yorkshire, and Mr Crowther explained some of the errors inherent in all laboratory methods designed to measure the "lime-requirement" of acid soils. The principal difficulty is that soil acidity is made up of an "intensity" and a "quantity" factor, which, on the close analogy of ordinary acidity, may be regarded as the expression of the degree of dissociation and total titratable acidity respectively. Lime requirement methods endeavour to express these two factors by a single value, and hence to this extent are imperfect.

The afternoon session, at the suggestion of the chairman, was devoted to a discussion of the present economic position of liming and chalking, as the urgent need for this operation on large areas of land is obvious. Col. Fenwick gave an account of the cost of preparing lime from chalk available on his estate, this works out at 10*s*. per ton exclusive of interest on capital expended in building the kilns. The operation is economically possible for a large farm where chalk is obtainable on the site and ordinary farm labour available. Mr Dampier Whetham alluded to the lasting effect of chalking and pointed out that the relative merits of lime and chalk should be carefully considered before any extensive national developments are planned, in order to decide whether available capital should be used for erecting lime-kilns or chalk-grinding mills. This point was also emphasised by later speakers Mr Garner, of the Hertfordshire Farm Institute, said that in the case of the large areas of land dangerously near the border line of acidity, he recommended one ton of lime per acre once in a rotation. The cost of this spread over four or five years is not serious. Some discussion arose as to the best time in the rotation for application of lime, and although there were individual preferences, it appeared that any crop was suitable with the obvious exception of potatoes.

Sir John Russell, in winding up the discussion, suggested that the immediate problems were: (1) to decide between the relative merits of lime and chalk, (2) to prepare a survey of areas needing treatment, (3) to supplement the geological maps by a survey of the relative accessibility of known deposits, (4) to decide what percentage of magnesium could be safely allowed in the deposits of magnesium limestone should these be used The conference expressed its approval of these suggestions and was unanimously of opinion that this urgent problem of soil acidity should be dealt with on a national basis, and that some form of loan or financial assistance to farmers is imperative if remedial measures are to be carried out under present economic conditions

University and Educational Intelligence.

CAMBRIDGE.—Mrs. Marshall has offered to the University, towards the expenses of the Marshall Library in Economics, the sum of 250*l*. annually during her lifetime, the profits from the sale of the "Memorials of Alfred Marshall," which is about to be published, and a further sum dependent upon the profits from the sale of her husband's books

The director of the Rockefeller Foundation has written an important letter to the University, giving to the University freedom to modify the plans with regard to the school of pathology which the Foundation recently endowed, should changed conditions or subsequent experience prove the modifications to be desirable. The terms in which this wise provision is made are worth recording; a clause is added to the deed of gift: "with the understanding that the University will in good faith give a full and complete trial over a period of years to its plan for which these funds are contributed but will not be obligated to continue in perpetuity any particular type of organisation or method of instruction."

The Vice-Chancellor announces the resignation on December 31 next of Dr. J. N Keynes, Pembroke College, from the office of Registrary of the University.

Mr. V. C. Robinson, Gonville and Caius College, has been appointed assistant to the Superintendent of the Museum of Zoology.

The Goldsmith's Company has announced that it is prepared to offer certain senior studentships to the total value of 750*l*. a year for post-graduate study.

EDINBURGH.—At the meeting of the University Court on Monday, May 18, the resignation was

intimated of Mr. William McClelland, lecturer in education, as from September 30, on his appointment to the joint post of professor of education in the University of St Andrews and director of studies at the St. Andrews and Dundee Training Centre

Major W S Patton, lecturer in zoology (entomology and parasitology), was granted leave of absence until October 1, 1926, in order to take charge, at the request of the Royal Society, of an investigation into kala azar in North China, in conjunction with Dr. Edward Hindle

Mr. K. P Brown was appointed lecturer in clinical surgery and Dr G. Buchanan lecturer in bacteriology

LONDON.—Dr. E. C. Dodds has been appointed to the University chair of biochemistry tenable at Middlesex Hospital Medical School Dr. Dodds studied at Middlesex Hospital Medical School and in 1918 was appointed demonstrator in physiology In 1920 he was appointed assistant in the Bland-Sutton Institute of Pathology, and since 1921 he has been lecturer in biochemistry in the Institute. He obtained the B Sc degree by research in physiology in 1922, and his doctorate in 1925. He has published numerous papers, either independently or in collaboration with others, in *Jour Physiol.*, 1921–24, *Jour Exp Path*, 1921 24, *Lancet*, 1921–25, *B M J.*, 1922–24, etc.

The title of emeritus professor of bacteriology in the University has been conferred on Prof Richard T Hewlett as from August 1 next, on his retirement from the University chair of bacteriology in consequence of the closing of the Department of Bacteriology and Public Health at King's College The resignation of Sir Halford Mackinder, University professor of geography at the London School of Economics, as from July 31, is announced

Birkbeck College will be recognised as a School of the University in the Faculties of Arts and Science for evening and part-time students, for a further period of five years, as from October 1 next.

The following doctorates have been conferred . D Sc (*Chemistry*) : Mr R W. West (Imperial College —Royal College of Science), for a thesis entitled "The Effect of Substituents on the Ease of Formation of, and on the Reactivity of the Bromine Atom in, Halogenated Malonyl Derivatives", Mr. Thomas Iredale (University College), for a thesis entitled "Adsorption from the Gas Phase at a Liquid-gas Interface, with special reference to the Adsorption of Vapours on a Mercury Surface", and Mr. W. G. Palmer, for a thesis entitled "The Catalytic Activity of Copper," and other papers, together with two subsidiary contributions D Sc (*Physiology*). Mr. B Babkin (University College), for a thesis entitled (*a*) "The Influence of the Blood Supply on the Pancreatic Secretion", (*b*) "Note on Reflex Hyperglycæmia." D.Sc (*Veterinary Pathology*) : Mr. A. L. Sheather, for a thesis entitled "The Diagnosis of Bovine Mastitis by Milk Examination," together with eight subsidiary contributions D Sc. (*Geography*) Mr C. B. Fawcett, for a thesis entitled "Provinces of England," together with nineteen subsidiary contributions.

Free public lectures on "Geodesy" will be delivered by Mr. A. R Hinks at Bedford College for Women, on June 3 and 5, at 5 15. No tickets will be required.

MANCHESTER.—The Senate has authorised the conferment of the degree of Doctor of Science upon Mr. Maurice Copisavow, Mr. Fred Fairbrother, Mr. Edwin Leonard Gill.

OXFORD.—On May 20 the annual Romanes Lecture was delivered by Sir William Bragg. The large audience present listened with appreciation to the lecturer's lucid exposition of the crystalline state, and followed with keen attention his demonstration, by means of lantern slides and other illustrations, of the way in which the use of the X-rays enables the constitution of the atoms and molecules of which crystals are built up, to become recognisable by our ordinary senses.

PROF. H. WIELAND, of Freiburg-im-Baden, has been invited to succeed Prof. Willstätter in the chair of chemistry at the University of Munich.

PROF K. FAJANS, of the University of Munich, has been invited to become professor and director of the Institute of Physical Chemistry in the University of Freiburg in succession to Prof G. Meyer. Prof. Fajans has also been nominated a corresponding member of the Russian Academy of Science.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for research scholarships, not exceeding seven in number, in agricultural and veterinary science. The scholarships will each be of the annual value of 200*l.* and tenable for three years. Applications must be received not later than June 30 on form 900/T.G., obtainable from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

THE Empire Cotton Growing Corporation proposes to award in July a number of studentships in relation to cotton growing, namely, research studentships and advanced study studentships, each of the value of 250*l.*, plus travelling expenses. Application forms may be had from the Secretary of the Corporation, Millbank House, 2 Wood Street, Millbank, S W.1. They must be returned by, at latest, June 22.

AN award of Ramsay Memorial Fellowships for research in chemistry will be made at the end of June. One Fellowship of the value of 300*l.*, open to graduates of all British universities, and one Fellowship of the same value for Glasgow graduates are offered. Forms of application, which can be obtained from Dr. Walter Seton, secretary of the Ramsay Memorial Fellowship Trust, University College, Gower Street, London, W C.1, must be returned not later than June 6.

THE feeling of the need for a university in the south of England was again to the fore at a meeting, held on Friday, May 22, at the Guildhall, Winchester, and addressed by Mr. Austen Chamberlain, M P., on behalf of University College, Southampton. For the College to become of university rank a sum of 500,000*l.* is necessary, and the meeting was for the purpose of opening a campaign to raise this sum. In the opinion of Dr. C. G Montefiore, president of the College, its present 400 full-time students could readily be made 800 so soon as its status is raised. The title suggested for the proposed new university is "The University for Wessex."

THE Society of Merchant Venturers offers for competition fifteen scholarships tenable in the day classes of the Faculty of Engineering of the University of Bristol, which is provided and maintained in the Merchant Venturers' Technical College. Candidates must be not less than 17 years of age and must have matriculated. Ten of the scholarships are restricted to the sons of officers in His Majesty's service who were killed in the War, while one is restricted to a son of a citizen of Bethune who has passed either the B.-ès-L. or the B-ès-Sc. examination. A War Memorial Scholarship is also offered with a preference to a candidate who is the son of a former student who lost his life while serving with the forces during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College.

Early Science at Oxford.

May 31, 1687. Mr. Caswel gave in a Table shewing ye difference between Kirching his Ephemeris and ye London Latin Ephemeris for ye present year 1687. Dr. Lister's Book *de cochleis Exoticis* was presented to the Society.

June 1, 1686. A letter from Mr. Flavel, a Physician in Newberry, to Mr. Anderton, was read: wherein he affirms that opening a great dog, before he was quite dead, in one of his kidneys he found a *worm* 16 inches long, and an inch in girth.

June 2, 1685. A Letter (dated May 28th) from Mr Aston S.R.S. brought newes, that the Councill of ye Royall Society has lately made an order, that such Persons, as are of the Oxford or Dublin Society, and likewise of ye Royall Society, in consideration of the charges they are at in ye places, where they reside, for carrying on the common work (ye discovery of Naturall Science) shall be excused half their weekly payments to the Royall Society, and be accountable to their Secretary only for £1 6s. per annum Which order shews such generous and reall encouragement for the advancement of Learning, that this Society, considering that many of their Members may enjoy the Benefit of it, think themselves very much obliged by it, and accordingly order'd their Secretary to returne their humble thankes to the Royal Society for it

A Letter from Mr Cole, dated Bristoll May 21 tells us, that the best time to see the severall colours afforded by the Purple-fish with the help of ye Sun is by drying the ting'd cloth in a Morning Sun

An account of a piece of Watch-work by Mr. Samuel Watson of Coventry was communicated and read, it is a *Moving Ephemeris*.

June 3, 1684. Mr Bernard, and some others of ye Society, gave an account that on ye 27th of May last in ye evening, they tried to discover ye *Spot* in ye *Sun*, which Mr Flamsteed had observed a month before, and which he conjectured would continue during a second revolution of the Sun, but they could discern nothing, tho they made use of a good telescope, 15 foot long, and ye air was clear

A letter from Mr. Wheeler was read, concerning ye description of a *watch*, invented by him, that may be so fram'd, as to move upon a declivity without any spring, or any other weight, then what is included in ye body of ye watch; wherein he also fully, and learnedly, shewed ye reason of its motion, and ye manner how it should be pois'd.

Dr. Plott then produced a peice of *Natrôn*, or Nitre, found on ye top of a lake in Ægypt, which he observed ye last year to yeild, and melt near ye time of ye riseing of ye Nile. He said it did not grow moist in ye thaw, nor all ye winter, but it began to relent three or four dayes agoe, and ye paper it was put in, was now moistened all over; He promised to observe its increase, or decrease of weight, and to give an account of it. Afterwards Dr. Plott read a discourse concerning *Vines*, observing that after ye late great *frost* ye Vines bearing *white* grapes have suffered much more, than those that bear *red*, and consequently seem more tender, especially the white *Muscadine*, which are (some of them) quite dead, but ye *Frontinjer*, *Burlake*, and *Rhenish*, not so; these springing again fresh from ye root, though all ye old branches are dead, and yet none of these have escaped so well as ye red, whose Branches are not dead above half way down but even amongst ye red grapes too, there is a difference.

1690. Sir George Mackenzy observ'd that ye highest, and coldest hills in Scotland had ye greatest quantitys of Shelly Concretions.

Societies and Academies.

LONDON

Royal Society, May 21.—W. E **Curtis** and R. G. **Long**: The structure of the band spectrum of helium. III. The doublet bands New data extend the main series to the eighth member Previous difficulties of interpretation are overcome by employing a non-integral quantum number $(m - \epsilon)$. For the earlier bands ϵ comes out $\pm\frac{1}{4}$ within the limits of error, but it departs from this value for the higher members of the series, except in the case of the Q branches, where it remains constant at $\frac{1}{4}$. The bands are capable of very accurate representation by the addition of a term $\beta(m - \epsilon)^4$ to the usual parabolic formula, and this leads to new and much more accurate values of the molecular moments of inertia and separation of the nuclei. This information, in conjunction with deductions concerning the electron orbits, affords support to Lenz's suggestion that the structure of the helium molecule may be related to that of the hydrogen molecule The results of the analysis of the second series of doublets are closely similar to those obtained from the main series The two series seem to originate from the same molecule, but a different radiating electron.—G. S **Adair** (1) A critical study of the direct method of measuring the osmotic pressure of proteins In certain solvents the osmometric observations on hæmoglobin satisfy the three criteria—permanence, reversibility, and reproducibility, therefore they may be regarded as true osmotic pressures. Readings remained constant within 6 per cent for nine weeks, and no products of protein breakdown could be detected in the outer liquids With rigorous control of conditions and with adequate criteria for equilibrium, the osmometer method proved thoroughly trustworthy, and when certain corrections were applied it proved capable of giving results accurate to 0·1 mm. of mercury, which corresponds to about one hundred thousandth of a degree in depression of the freezing point (2) The osmotic pressure of hæmoglobin and the absence of salts In the theory of hæmoglobin solutions previously accepted, the molecular weight of pure hæmoglobin is supposed to be equal to the equivalent 16,700, and it was supposed that traces of salts caused aggregations Pressures corresponding to the theory were obtained only in the presence of ionising impurities, and it is suggested that the so-called aggregation changes are better explained by the theory that the observed pressure is the sum of the hæmoglobin partial pressure and the partial pressure of undialysed impurities.—J. W. **Fisher**: Some further experiments on the gyromagnetic effect. It was sought to detect a gyromagnetic effect by magnetising a substance (in most cases magnetite) by a rotating magnetic field and looking for a component of magnetisation in a direction perpendicular to the plane of rotation of the field; such a component would be expected to arise if a rotation of the magnetic axes of the molecules is set up by the rotating field Fields rotating at frequencies of 2 to 5×10^4 cycles per second gave no evidence of an effect of this kind even for rotating fields of more than 100 gauss.—G. A. **Elliott** and I. **Masson** Thermal separation in gaseous mixtures Equilibrium thermal separations have been measured, with nearly constant temperature difference approaching 500° C., for mixtures of hydrogen, helium, and carbon dioxide, taken two at a time and in varying proportions. The results obtained are unexpectedly high In each case the constituent of higher molecular weight becomes more concentrated in the cold part of the mixture. The greatest separation was obtained from mixtures such that the cold side contained about 55 per cent. of

hydrogen in hydrogen-carbon dioxide, about 60 per cent. of helium in helium-carbon dioxide, and about 60-55 per cent. of helium in hydrogen-helium mixtures. The displacement seems to be specific for helium, whether it is the lighter gas of the pair or not. The separations observed may be attributed almost entirely to mutual intermolecular actions, and not appreciably to differences in the individual thermal expansibilities of the constituents of the gas mixtures.—O. W. **Richardson**: Structure in the secondary hydrogen spectrum. The paper deals with 10 lines of this spectrum previously classified by Richardson and Tanaka as $52P(m)$. These, together with 24 additional lines, are now rearranged as two new P series, two new Q series, two new R series and a fragment each of a P and Q series. The P and R series have a superficial resemblance to a doublet band. The seven series show four sets of intercombinations. There are abnormalities which show a curious similarity throughout the different sets of term numbers.—C. N. **Hinshelwood** and C. R. **Prichard**: The catalytic decomposition of nitrous oxide on the surface of gold. At 834°-990° C. the surface reaction is unimolecular and is unretarded by oxygen. The gold provides a temporary abode for oxygen atoms, so that the reaction $2N_2O = 2N_2 + O_2$ can resolve itself into

$$N_2O = N_2 + O,$$
$$O + O = O_2$$

Probably every molecule of nitrous oxide which strikes the gold wire with a kinetic energy greater than 30,000 calories per gram-molecule gives up its oxygen atom.—E. H. **Callow**: The velocity of ice crystallisation through supercooled gelatin gels. With "ash-free" gelatin, increase in concentration of gelatin causes decrease in velocity of crystallisation. Such decreases are considerable for concentrations above 1 per cent. (above 2 per cent. at P_H 4·75), *e.g.* at P_H 1·50 the velocity through a 1 per cent. gel is 960 cm./hr. (about half the velocity through distilled water), and that through a 1·5 per cent. gel is only 40 cm./hr. When the hydrogen-ion concentration is varied by means of hydrochloric acid, the velocity is a minimum near the iso-electric point of gelatin and a maximum about P_H 2·6. Sodium hydroxide increases the velocity. Neutral salt causes a slight increase in velocity of crystallisation through gelatin-water gels, but when sodium chloride is added to gelatin-chloride gels there is a marked decrease in velocity.—R. C. **Johnson**: Further spectra associated with carbon. The effect of helium on carbon spectra has been investigated in the ultra-violet region. The comet-tail spectrum and a new line spectrum of carbon have been completely measured. The new lines probably constitute the true "arc" spectrum of carbon. No series relationships have, however, been identified. A new band spectrum associated with the comet-tail bands has also been measured and disposed in series. Under the conditions in which the above spectra were produced in helium, the negative band spectrum of carbon was developed with great strength.—W. **Sucksmith**: The gyromagnetic ratio for magnetite and cobalt.—Ian **Sandeman**: The secondary spectrum of hydrogen at higher pressures. With the aid of the arc spectrum a band has been selected with head at 4582·58 Å.U. and shading towards the violet. The value of the initial moment of inertia of the molecule emitting the band, when calculated by the aid of the formula of Kramers and Pauli, comes out as $19·326 \times 10^{-41}$ gm. (cm)^2, agreeing with the value predicted by a static model of triatomic hydrogen, H_3. The lines of the P, Q, and R combination discovered by Richardson and Tanaka are also present in the same condition of the arc, and the intensity distribution found for them agrees with that found for the new band.

Mineralogical Society, March 17.—S. **Tomkieff**: The structure of aragonite. A new method of etched figures which can be used for the estimation of crystal structure is described. A structure of aragonite, constructed in such a way that the transformation into calcite can be attained with a small expenditure of energy, has been tested by this method. For six of the eight faces examined the spacings are the same as those observed by Sir William Bragg, but the remaining two give only half of the spacings observed. This anomaly is explained by the hypothesis that aragonite in its natural occurrence has undergone a partial transformation into calcite. The structure proposed is unable to explain the intensities of X-ray spectra. Aragonite is considered to be pseudo-orthorhombic.—I. E. **Knaggs**: Crystalline structure of penta-erythritol tetranitrate. From X-ray examination, the dimensions of the ditetragonal bipyramidal unit cell are $a = b = 13·2$ Å.U., $c = 6·66$ Å.U., and it contains four molecules, each possessing fourfold symmetry. The crystals are built on the Bravais lattice Γ_1 and belong to the space-group D_{4h}^{7}. A structure is proposed in which the molecules have a digonal axis with two planes of symmetry parallel to (100) intersecting in it. There is a considerable departure from the tetrahedral angle of the bonds from the central carbon atom of the molecules. The strain caused thereby, together with the comparative proximity of eight oxygen atoms at intervals in the structure, may contribute to the explosive nature of the compound. The configuration of the nitro-group ($-NO_2$) is in favour of the oxygen atoms being equivalent.—E. D. **Mountain**: Potash-oligoclase from Mt. Erebus, South Victoria Land, and anorthoclase from Mt. Kenya, East Africa. Felspar crystals of two types, occurring in the tuffs of Mt. Erebus, have a chemical composition intermediate between anorthoclase and andesine and are referred to potash-oligoclase, being identical with certain rhomb-porphyry phenocrysts. Similar crystals from Mt. Kenya and Kilima-njaro contain less lime. A complete series of felspars exists between anorthoclase and andesine having continuously varying properties and mostly of porphyritic occurrence. This necessitates a slight modification in the definition of kenyte, but the limits of the type must depend upon the natural series rather than upon any chemical distinction.—A. **Brammall**: Further notes on the association of lime with other oxides of RO-type in minerals. Volume-relationships accentuate the differences in chemical behaviour between lime on one hand and magnesia, ferrous oxide, and manganese oxide on the other, and partly control those early molecular associations which promote differentiation in the fluid magma. Particular cases of differentiation in the Dartmoor granite furnish features analogous with those of the anorthosite-peridotite schism, and suggest also that a high concentration of ferrous oxide and magnesia promotes the early separation of orthoclase as phenocrysts, and the zoning of the ground-mass plagioclase.—G. **Greenwood**: Crystallographic data of some new organic compounds.

Royal Anthropological Institute and the Prehistoric Society of East Anglia (Joint Meeting), April 21.—Mr Henry **Balfour**: The status of the Tasmanians among Stone Age peoples. The Tasmanians are probably the only people of whom it can be said with confidence that they remained into quite recent times (to the middle of the last century) in an arrested culture-phase which may be described as strictly palæolithic. A decided similarity can be indicated between the form and technique of many Tasmanian implements and certain characteristic implements of the Mousterian series. Many of the

types of implements which are particularly characteristic of the Aurignacian culture-horizon are well and abundantly represented in the Tasmanian series. One of the types, which is particularly associated with the Aurignacian division, *i.e.* the "grattoir à museau" of French archæologists, is by far the most abundant of the Tasmanian tools, and it is very significant that the implements within this category exhibit very commonly a flaking technique—a very delicate parallel flaking—which is identical with that which has been specially named "la retouche aurignacienne." The characteristic, more specialised implements of Tasmania, then, suggest a dual analogy—Mousterian and Aurignacian—and if we evaluate the status of this culture in accordance with the highest achievements, we must base our estimate chiefly upon the Aurignacian analogy and promote the Tasmanians to a culture level comparable with that of early late-Palæolithic man. The resemblance is only partial, since several important elements in the culture of Aurignacian man are missing from that of the Tasmanians.—Nina F. **Layard**: Recent excavations at the neolithic site of Sainte-Gertrude, Holland. Excavations were carried out in October last at the neolithic station of Sainte-Gertrude, Holland, undertaken by the kind permission of M. le Comte René de Geloes, and under the auspices of the Trustees of the Percy Sladen Research Fund. Points of special interest which were observed were the following. Division of labour, suggested by the finding of ateliers specially devoted to the turning out of one type of implement—thus a profusion of picks on one spot, axes on another, and cores found in abundance on a third; the extraordinary number of implements argues either a long occupation or a large number of settlers; the working places were not the living places; the equipment of the miner included picks, axes and racloirs, habits of economy are very noticeable—witness the number of refashioned tools. A comparison of the various implements found at Sainte-Gertrude, with those from Cissbury, Grimes' Graves, and other neolithic mining stations, may help in the dating of these English sites.

MANCHESTER.

Literary and Philosophical Society, March 31.—G. H. **Carpenter**: Collembola from southern New Zealand. There are species of the widespread genera Pseudachorutes from Mount Algidus, as well as of Paronella which had previously been known across the eastern tropics from West Africa to Queensland. But the most important discoveries are a species of Cryptopygus at Ben More, Canterbury, and two species of Lepidophorella. The former had previously been known from Graham Land and the South Orkneys; the latter from Chile and Patagonia. Their presence in New Zealand and its outlier is most suggestive for comparison with distributional facts derived from the study of other groups which indicate ancient extensions of antarctic and sub-antarctic lands.—F. E. **Weiss**: On the structure of the leaves of the graft-hybrids, *Crataego-mespilus Asniersii* and *Crataego-mespilus Dardari*. It has been a common practice on the continent to graft the medlar (*Mespilus germanica*) on the stem of the hawthorn (*Crataegus monogyna*). In several instances shoots have been produced from near the region of the graft which partook of the nature of both stock and scion. These have been termed graft-hybrids. In the leaves of the two forms discussed, in the former the epidermal cells of the upper surface of the leaves are in surface view small and more or less straight-walled like those of the hawthorn, and not large and sinuous as in the medlar. The resemblance to the hawthorn may be due to the fact that the leaf is in shape and size more like that of the hawthorn than the medlar. The leaves of *Crataego-mespilus Dardari*, which are in shape more like those of the medlar though smaller in size, have epidermal cells, intermediate in shape and size between those of the medlar and hawthorn. If these graft-hybrids are periclinal chimæras, their epidermal cells have in the leaves at all events been modified to a great extent by the underlying tissues, with which they are no doubt organically connected by protoplasmic threads.

PARIS.

Academy of Sciences, April 20.—Le **Prieur**: With the De Goys expedition from Paris to Gao. An account of the results obtained with the author's apparatus (which automatically records the path taken by an aeroplane), in two air voyages between Paris and Gao, a distance of 4000 kilometres.—Bertrand **Gambier**: The surfaces of translation of Sophus Lie.—A. **Lafay**: A means of modifying the wake of a cylinder moving in a fluid.—B. **Hostinsky**: The theory of magnetism in movement by Poisson.—F. **Baldet**: The influence of pressure on the band spectra of carbon in the thermo-electronic bulb. Consequences for the theory of comets. It is shown that the pressure plays an essential part in the existence of the different groups of carbon bands.—Arvid **Leide**: Researches on the *K* series of the X-rays. The table given shows the results of the measurements in the zone 29Cu-53I.—A. **Maubert**, L. **Jaloustre**, and P. **Lemay**: The influence of radium on the catalase of the liver. As with the bromide of thorium-X, radium in strong doses paralyses while in weak doses it activates the catalase. Radium emanation acts similarly, at least with small doses. The only difference observed between the effects of radium and thorium-X is that the β and γ rays of radium reduce the activity of catalase, an effect not observed in the earlier experiments with thorium-X.—Mlle **Germaine Cauquil**. The thermochemical study of the sodium derivatives of cyclohexanol.—Marcel **Frèrejacque**: The structure of the phenylhydrazones of glucose.—Henry **Dervillé**: The facies of the carboniferous limestone in the Boulonnais.—E. F. **Gautier** and J. **Savornin**: The red layers of Ouaouizert (Central Morocco).—Pierre Le **Conte**: The regime of the waters of the Channel and the transformation into heat of a fraction of the energy of the tidal currents.—M. **Bridel** and C. **Charaux**. The products of the ferment hydrolysis of rhamnicoside: primeverose and rhamnicogenol. The hydrolysis of rhamnicoside by a ferment produces primeverose and rhamnicogenol in accordance with the equation

$$C_{26}H_{30}O_{15}+H_2O=C_{11}H_{20}O_{10}+C_{15}H_{12}O_6$$

Rhamnicogenol is a derivative of methylanthranol.—René **Jeannel**: Apterism in insular insects. The study of Trechinæ in various localities shows only one example which might be interpreted as a case of apterism produced by isolation in an island; this is *T. quadristriatus* in the island of Elba. Other examples from Madeira, the Canaries, Corsica, and Sardinia prove, on the contrary, that the fact of living on an island has no effect in producing disappearance of the wings.—Edouard **Chatton** and Mme **Chatton**: The action of external factors on the Infusoria. The determinism of the formation of chains in Colfidium.—F. **Diénert**: The purification of water.

Official Publications Received.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 22, January. Pp 234 (London: Institution of Civil Engineers.)

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 1, No. 7 An Investigation of the Absorption of Superposed X-radiations By Wm. H. Watson Pp 48-58 1s Vol 45, Part 1, No. 8: The Stability of Suspensions. (1). The Rate of Sedimentation of Kaolin Suspensions by Salts at varying Hydrogen Ion Concentrations. By William Ogilvy Kermack and William Turner Horace Williamson. Pp. 59-70. 1s. Vol. 45, Part 1, No 9 The Influence of Gelatin on the Stability of a Colloidal Solution of Cholesterol, and on the Charge on the Particles By William Ogilvy Kermack and Peter MacCallum Pp 71-89 1s 6d Vol 45, Part 1, No 10 The Action of Salts with Multivalent Cations on Colloidal Solutions of Gold and Gum Benzoin By William Ogilvy Kermack and Cecil Innes Rothwell Voge Pp 90-101 1s (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Ministry of Health. Advisory Committee on Water. Report on Measures for the Protection of Underground Water Pp 19 (London: H.M. Stationery Office.) 2d net

The Physical Society of London. Proceedings, Vol 37, Part 3, April 15 Pp 101-194. (London: Fleetway Press, Ltd.) 6s net

Proceedings of the Cambridge Philosophical Society. Biological Sciences Vol. 1, No 4, April Pp 219-277 (Cambridge: At the University Press.) 12s 6d net.

Aeronautical Research Committee. Reports and Memoranda. No 934 (Ae. 155) Wind Channel Tests on Radiators. By R. G. Harris and W. K. Alford Pp 16+5 plates 1s. net No 942 (Ae 162) The Royal Aircraft Establishment Control Movement Recorder, Mark III. By D. A. Jones and H. L. Stevens Pp 8+8 plates 6d net. No. 943 (Ae 163). Tests of three Aerofoils suitable for High Speed. A.D. 1, Sloane, and R.A.F. 26. By F. B. Bradfield and A. S. Hartshorn Pp 6+6 plates 6d. net No 944 (Ae. 164) Measurement of Pitching Moments due to Roll on Wings of Avro 504 K By F. B. Bradfield Pp 6+2 plates 4d net No. 945 (Ae 165) Lift and Drag of Junker Monoplane; Comparison of Model with full scale Results By B. D. Clark, L. P. Coombes, H. Glauert and A. S. Hartshorn Pp 10+10 plates 9d net No 946 (Ae. 166) The Theory of the Design of Aerofoils, with an Analysis of the Experimental Results for the Aerofoils R.A.F. 25, 26, 30 to 32 By H. Glauert Pp 7+8 plates 6d net No 948 (Ae 168) An Experimental Investigation into the Properties of certain Framed Structures having Redundant Bracing Members By Prof. A. J. Sutton Pippard Pp 25+6 plates. 1s 3d net (London: H.M. Stationery Office.)

The Volcanic Activity and Hot Springs of Lassen Peak By Arthur L. Day and E. T. Allen. (Publication No 360.) Pp viii+190+14 plates (Washington: Carnegie Institution.)

Rhodesia Museum, Bulawayo. Twenty-third Annual Report, 1924 Pp 12 (Bulawayo.)

Field Museum of Natural History. Report Series, Vol 6, No 4. Annual Report of the Director to the Board of Trustees for the Year 1924 (Publication 227.) Pp 265-383+plates 47-62. (Chicago.)

Ministry of Agriculture, Egypt. Technical and Scientific Service (Botanical Section) Bulletin No 55. Ratoon Cotton in Egypt, a Preliminary Note. By James Templeton Pp. iii+14+1 plate (Cairo: Government Publications Office.) 5 P.T.

Department of the Interior. Bureau of Education Bulletin, 1924, No 17. American School Buildings By Fletcher B. Dresslar. Pp ix+100+45 plates (Washington: Government Printing Office.) 45 cents

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield Vol 7, 1924. Pp iii+175 (Sheffield.)

The Institute of Physics. Report of the Board for the Year 1924. Pp 15 (London.)

Bergens Museum, 1925. en historisk fremstilling redigert av professorkollegiet Pp 528. (Bergen.)

Nauka Polska: Jej Potrzeby, Organizacja i Rozwój Tom 5 Pp vi+553 (Warszawa: Im Mianowskiego.)

La science polonaise: ses besoins, son organisation et ses progrès. Résumé français des articles parus dans le volume 5. Pp 36. (Varsovie: J. Mianowski.)

Proceedings of the Royal Irish Academy. Vol 37, Section A, No 1: The Equilibrium of Ionisation in the Atmosphere By Prof. J. J. Nolan, R. K. Boylan and G. P. de Sachy Pp. 12 1s Vol. 37, Section B, Nos. 4, 5 The αα and αγ Isomerides of 2 4 6 3' 4'-Pentamethoxy Diphenyl Propane, by J. J. Drumm, Norah G. J. O'Reilly and Prof. Hugh Ryan, The Condensation of Aldehydes with Methylethylketone, by Prof. Hugh Ryan and John J. Lennon Pp 19-36 1s (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Bulletin of the American Museum of Natural History Vol. 51, Art. 9: A Revision of the Mesozoic Crocodilia of North America. By Charles C. Mook Pp 319-432+plates 4-5 (New York.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 6, Memoir No 4: Upper Carboniferous Fossils from Chitral and the Pamirs By Dr. F. R. Cowper Reed. Pp. v-ii+124+10 plates. 9 13 rupees, 15s. 3d New Series, Vol 8, Memoir No 2. The Anthracotheriidæ of the Dera Bugti Deposits in Baluchistan. By C. Forster Cooper Pp iv+60+7 plates 4 rupees; 6s 4d. (Calcutta: Government of India Central Publication Branch.)

Memoirs of the Geological Survey of India. Vol 48, Part 2: The Geology of parts of the Persian Provinces of Fars, Kirman and Laristan. By Dr Guy E. Pilgrim Pp. vi+116+plates 11-16 (Calcutta: Government of India Central Publication Branch.) 3 12 rupees; 6s. 3d.

Survey of India. General Report for 1923-24, from 1st October 1923 to 30th September 1924. Prepared under the Direction of Col. E. A. Tandy. Pp. vii+66+ii+7 maps. (Calcutta.) 2 rupees; 3s. 6d.

Canada. The Dominion Fuel Board in co-operation with the Geological Survey, Department of Mines. Smoky River Coal Field: Examination and Comparison with the Kananaskis Area By James McEvoy. Pp. x+19+5 plates. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Geological Survey. Bulletin No. 39: Colour Printing of Geological Maps. By C.-O. Senécal. (Geological Series No. 44.) Pp. iv+4 plates. (Ottawa: F. A. Acland.)

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whitehill, near Matjesfontein), for the Year ending 31st December 1924. Pp. 23. (Kirstenbosch.)

Diary of Societies.

SATURDAY, MAY 30.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—R. Chambers and P. Reznikoff: Studies on the Plasma Membrane and Physical State of Protoplasm by Micro-dissection and Micro-injection.—C. Shearer: Child's Hypothesis.—J. S. Huxley: Some Problems of Differential Growth.—Dr. W. H. Pearsall: Rates of Growth and Plant Form.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (II.).

MONDAY, JUNE 1

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

WEDNESDAY, JUNE 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington: The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (III.).

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Dr. C. H. Mayo: A Consideration of Gastric and Duodenal Ulcer.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. R. L. Smith-Rose: The Effect of Wave Damping in Radio Direction-finding

ENTOMOLOGICAL SOCIETY OF LONDON, at 8

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone) (*continued on June 4, 5, 6*).—Sir John Russell: The Place of Science in Rural Life (Presidential Address).—A. G. Tansley: The Vegetation of the English Chalk.—A. L. Leach: New Road Sections in North Kent.—E. C. S. Baker: Field Naturalists and Evolution.—G. L. Pepler: Regional Survey in East Kent.—D. W. Cutler: Life in a Garden Soil (Evening Lecture).—Sir Arthur Smith Woodward: The Evolution of Fishes (Evening Lecture).—Capt. J. J. Eckersley: Broadcasting (Evening Lecture)

THURSDAY, JUNE 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O. Bower: The Natural Classification of Ferns as a Study in Evolution (III.).

CHEMICAL SOCIETY, at 8.—W. A. Wightman: The Spatial Structure of Cycloparaffins. Part I. A New Aspect of Mohr's Theory and the Isomerism of Decahydronaphthalene.—Dr. T. A. Henry and H. Paget: Chenopodium Oil. Part II. The Hydrocarbon Fraction.—J. A. Goodson and Dr. T. A. Henry: Echitamine

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section) (Annual General Meeting), at 8.—Dr. A. Willett: Placenta Prævia treated by Traction on the Fore-coming Head.—D. C. L. Fitzwilliams: Curiosities in Connexion with the Secretion of Milk

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (*See June 3 for programme.*)

FRIDAY, JUNE 5.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Summer Meeting), at 10 A.M.—Dr. Tapia: The Big Pharyngostomes as an Accident in Laryngectomy: How they can be Avoided and the way of Closing them.—Dr. C. Mayo: Methods of Caring for Diseases of the Pharynx, Larynx, and Mouth.—Dr. R. Rodger: Tracheotomy in Tuberculous Laryngitis.—Dr. A. L. Turner and Dr. F. E. Reynolds: Furuncle of the Nasal Vestibule and Cavernous Sinus; Thrombosis the Pathway of Infection.—Dr. J. S. Fraser: Intra-nasal Dacryocystotomy.—At 3.—Clinical Meeting.—Prof. Burger: Pharyngeal Voice in a Case of Complete Laryngectomy.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 5.30.—Extraordinary General Meeting.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—W. Worrall: Dictionary Evening

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. J. Brill and H. B. Milner: The Geology of the Eastbourne-Hastings Coastline.—G. S. Sweeting: The Geology of the Country around Crowhurst.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Howard Carter: The Tomb of Tut-Ankh-Amen from the Ante-Room to the Burial Chamber.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (*See June 3 for programme.*)

SATURDAY, JUNE 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (III.).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (*See June 3 for programme.*)

FREE PUBLIC LECTURES.

WEDNESDAY, JUNE 3.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—A. R. Hinks: Geodesy. (Succeeding Lecture on June 5.)

THURSDAY, JUNE 4.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Sir Arthur Keith: The Structural and Functional Disorders of the Great Bowel.



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MACMILLAN & CO., LTD.,
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Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 2901, VOL. 115]

An Imperial Research Committee.

MOST of Britain's tropical possessions were acquired by accident rather than by design. The home government has never exhibited any particular anxiety to undertake the obvious initial responsibilities of the administration of new territories. It has left to poorly paid local administrative officers the task of meeting expenditure on the essential services out of taxation of the populations committed to their care The efficiency of these officers is measured by the home authorities, not by the development of the potential resources of a country, not by the happiness, health, and growth of the native populations, not by any enterprise they display in fostering the introduction of new varieties of economic crops, but solely by their success in balancing their budgets. As a general rule, the governors have been "safe" conventional-minded men, unable even in a crisis to stir the home authorities into action.

The result of this attitude of conventional indifference to progress, to the possibilities of the applications of science to the development of the vast potential resources of Nature, is nowhere more strikingly exemplified than in British tropical possessions After thirty years of British occupation, the agricultural implements principally used by the natives of East Africa are the stick and the hoe. In a country hungry for motor-spirit, the whole of the bye-products of an immense colliery are wasted. In territories where the distances between centres of administration are great, and the difficulties of maintaining telegraph wires are many, no attempt is made to establish wireless communication.

Years elapse before discoveries made in one territory regarding the new treatment of a human disease, yaws, for example, are communicated to the neighbouring administration. Although it appears to be definitely established that the shifting cultivation practised by the native populations, involving as it does the destruction by burning and ring-marking of the primary forests, is responsible for the impoverishment of the soil and the progressive desiccation of Africa, no serious attempt has yet been made to put a stop to the practice of grass-burning. In certain territories, cotton has been introduced and its cultivation fostered, but no adequate safeguards have been taken to prevent the distribution of dirty seed to the natives, with the result that preventable diseases have been introduced. In others, where richer cattle food would vastly improve the quality and efficiency of draught oxen, cotton seed is being burned for fuel at ginneries and molasses from local sugar factories is being wasted, both of which are valuable ingredients in cattle food.

The sudden enthusiasm of an administration for the increase of a particular economic crop might, by restricting the area under food crops, bring about a disastrous famine. This kind of enthusiasm might easily result also in the crops being planted in wholly unsuitable soils The decision to raise taxes on a commodity might, as in the case of the salt tax in India, result in such a reduced consumption of a vital commodity that the efficiency of the population be greatly reduced

Many other problems arise in dealing with the native populations. The sudden change in the traditional habits of a tribe, for example, the restriction of their freedom of movement from one site to another, might easily be responsible for an appalling outbreak of disease. Pastoral tribesmen, encouraged to work in factories and mines, are particularly subject to tuberculosis. The incidence of taxation on a tribe which is too remote from the transport system of the country to make the production of economic crops a practical proposition results too frequently in the male members of the tribe being forced to seek work in districts far removed from their homes This has not only a bad effect on the birth-rate of the tribe, but results also in the introduction of disease on the return of the men to their homes. Even the prevention of tribal warfare is not an unadulterated blessing. The cessation of tribal warfare has led to a marked deterioration in the domestic stock of the natives, due largely to the lack of knowledge of animal husbandry among the natives Then again, if natives from a grain-eating district migrate in search of work to a district where the natives subsist on ox-blood and milk or bananas, there is a great deal of debility due to digestive troubles

It can safely be said that these and many other problems and possibilities are only just being realised by the administrations in our various tropical possessions, and we are further from the solution of most of the problems than we are from the appreciation of the possibilities of the economic development of the territories

The recent announcement, therefore, by the Prime Minister, in a characteristically eloquent speech in which he paid a tribute to the enthusiasm of the late Lord Milner for research, that in appointing the Earl of Balfour as Lord President of the Council he was giving the people of Great Britain an earnest of the intention of the Government to see that the matters of co-operation and co-ordination in scientific work throughout the Empire should be regarded as the first work of a man peculiarly fitted for the responsibility, is particularly welcome. This announcement, moreover, was followed by another by Lord Balfour himself a few days later. In the course of the debate in the House of Lords on Kenya Colony on May 20, the Archbishop of Canterbury, referring to the scientific chapters of the "brilliant Report" of the East African Commission, pleaded for the "scientific inquiry into all the conditions of climate, soil, fauna, flora and population in all these [East African] areas" as recommended in the Report, and suggested that a certain percentage of the 10,000,000*l.* loan recommended for the development of the transport system of the territories should be "definitely devoted to such preliminary inquiries on a large and really worthy scale by competent men" In replying for the Government, Lord Balfour gave a clearer indication of its intention with regard to Imperial research.

Referring to the Report of the East African Commission, he asked, was it not clear from a study of that document that what was wanted was some machinery by which the larger problems which we now saw were presented to us by the vast area in East Africa, and other problems from other parts of the Empire, could be conveniently considered in their entirety? He stated that the Government is of the opinion that an institution bearing a resemblance to the Committee of Imperial Defence should be set up for dealing with the purely civilian problems which become more and more insistent in connexion with Imperial development. This body is to be the direct creation of the Prime Minister. It will advise the Cabinet, it will provide machinery for examining problems with which there is at present no Departmental method of dealing, and, having examined them and formed an opinion, the Cabinet will then have to decide upon the applicability of its recommendations to the necessities of the case and practical possibilities of carrying them out.

This sudden resolve of the Government, for which the scientific member of the East African Commission, Major Church, must be given no little credit, is made none too soon. The eyes of the civilised world are focussed on the British overseas territories. The attitude of dispossessed Germany and of certain of our commercial rivals is severely critical, and not without justification they consider that we have undertaken vast additional responsibilities with which our existing machinery of government is unable to cope. They consider also that among these responsibilities is that of developing the vast natural resources of the countries in our keeping.

The advantages of an Imperial Research Committee are obvious. Only those who have visited the colonies, and adjacent territories in a tropical country, can fully appreciate the isolation of the scientific workers in those territories, so complete that discoveries or activities in one territory are absolutely unknown in those adjacent to it. Then again, as is clearly indicated in the Ormsby-Gore Report, some administrations have not yet sufficiently understood or formulated their problems

to realise the services which their solution demands. Furthermore, there is no real existing over-riding authority which can effectively enforce the co-operation of the various administrations in a campaign against a common menace, be it tsetse-fly, pink boll-worm, rinderpest, or venereal disease. There are other advantages also. Unless Major Church had been a member of the East African Commission, very few of the local scientific workers would have been given the opportunity to express their views on the problems arising in the development of their respective territories. There is virtually no committee existing at the Colonial Office which acts at all adequately as a liaison and advisory body to colonial scientific officers. Still less is the present Colonial Research Committee in a position on its own initiative to make proposals embodying a research programme to the Secretary of State. It is true that the Imperial Institute does act as a consultative body to the Crown Colonies and some of the British Dominions, and that it gives advice when asked for it. But it is clear that what is envisaged, and what is needed, is an authoritative body which shall be in a position to formulate a policy and programmes for research without waiting necessarily for a stimulus from abroad.

From another point of view the proposal is most gratifying to the general body of men of science. In essence, it is a recognition of the all-important rôle of the scientific worker, not only in the development of the Empire, but also in the life of any community. We may eventually reach the stage in human development when workers in pure and applied science are at the top of the pillar of public esteem, when the fact is appreciated that science rightly used, and the scientific outlook, may not only save us from social disasters and material wants, but also lift us to hitherto unimaginable heights of life and illumination.

If the Imperial Research Committee is formed, and if it fulfils its proper functions, we shall be travelling a stage further along the road of progress. It is essential, therefore, that those of us who guard the interests of science and believe in the worth of scientific knowledge should watch with jealous care the selection of this Committee. We do not hesitate to suggest that included in this august body, charged with such grave responsibilities, should be the member of the East African Commission, to whose labours, in the main, the project is due. The Report of the Commission is made particularly distinctive from our point of view by its treatment of the scientific aspects of the problem of development of the promising territories surveyed, and the spirit of this statement is exactly what is wanted to inspire the work of an Imperial Research Committee.

River Regulation.

Regulation of Rivers without Embankments: as Applied in the Training Works at the Headwaters of the Rangoon River, Burma (locally known as the Myitmaka Training Works). By F. A. Leete, assisted by G. C. Cheyne. Pp. xii + 122 + 36 plates + 10 maps. (London: Crosby Lockwood and Son, 1924.) 30*s.* net.

THE practice of the science of river training and regulation is beset by so many difficulties, and success has often to be achieved in the face of obstacles and impediments of so intractable a character, that the suggestion that a river may be left to effect its own training is, at first sight, a little startling. One may even experience a slight feeling of incredulity in glancing at the title of the book forming the subject of this notice, which will be intensified, indeed, when it is found that the author includes within the term "embankments" all artificial aids to bank formation, with the exception of certain sticks of bamboo. At the same time, it must be observed that as the object of training works is to produce embankments of a permanent character, the signification of the word in the title is particular and limited.

Obviously, the title chosen is, in a sense, paradoxical, but the book certainly indicates a novel and ingenious method of river training, which is clearly demonstrated to be of the highest value and utility in the cases in which it has been employed. Before dealing with the limitations of its application, we will briefly describe the method itself.

The scene of the operations described is in Burma, among the headwaters of the Rangoon River. These streams, principally used and, in normal condition, highly serviceable for the transportation of logs of teak from the uplands to the coast, are fed by hillside torrents taking their rise in the range of mountains known as the Pegu Yomas, which form the eastern boundary of the watershed of the river Irrawaddy. These hills have an extreme altitude of about 2500 feet, and they are composed of very friable sandstones and shales. The rainfall varies from 60 to 120 inches, and during the monsoon period, when the precipitation is a maximum, the hill streams come down in high flood at frequent intervals, carrying immense quantities of sand and clay in suspension Spreading themselves out, on reaching the foot of the hills, in a network of shallow and interlacing channels, the flood waters are dispersed over the plain, submerging the paddy fields and producing a series of swamps and *lahas* (the native term for tracts inundated annually). For log transportation, such a regimen is in the highest degree a source of trouble and expense. Before regulation was undertaken, very few logs found their way to the main

Rangoon River (locally known as the Myitmaka) without assistance; most of them were left stranded in the shallow channels, or scattered over the rice fields. Some were lost, others abandoned, and many were only retrieved at considerable labour by dragging them for long distances by means of elephants (Fig. 1).



FIG. 1.—Dragging of logs through mud by elephants. From "Regulation of Rivers without Embankments."

attempts at regulation. High embankments, successful enough but costly to construct, were succeeded by low embankments, also with satisfactory results, until the inspiration came, in 1917, that no artificial embankments at all were necessary. Observing the effect produced on the silt-laden stream by stranded logs and other debris, round which deposits accrued, the trial was made of a fencing of bamboo stakes along the desired line of embankment. The result fully justified the expectations which had been formed. The stakes became embedded in deposit, which



FIG. 2.—Bamboo stake fencing, usual type adopted since 1917. The stakes seen in picture originally stood 3 ft. out of the ground. From "Regulation of Rivers without Embankments."

The condition of affairs appeared to be so hopeless in 1910, that sanction was given to a project for stopping the logs at the railway line and sending them on to Rangoon by rail.

It is superfluous to follow closely the history of the

gradually accreted to heights ranging up to 9 or 10 feet, or even more. Natural embankments were thus formed, completely defining the channel and keeping the stream within bounds.

For a fuller and precise description of the preliminary measures, we quote Mr. Leete's own words:

"The line along which it is desired to form the new channel is pegged out, and usually follows more or less the natural depression. All jungle growth to a width of 150 feet on each side of the line is cut down flush with the ground, and burned or cleared away. One hundred feet on each side of the line, simple bamboo fences are made. These consist of pointed bamboos, 5 to 6 feet long, driven into the ground about 9 inches apart, with their tops dressed to a steady slope and about 3 feet above ground level. These stakes are lashed to a horizontal rail, with coir rope, about 6 inches from their tops, to hold them in position (Fig. 2). Where this fence crosses side channels, the bamboos naturally stand higher out of the ground, and must be strutted to withstand the additional pressure at these points. Bad bends are eliminated by short cuts, protected by additional strutted fencing.

"During the early rises . . . the water tends to spread out over the country. It is at this time that the fences do their best work. They catch up the many kinds of small rubbish brought down on every jungle rise, and form a barrier checking the flow of the water. The check to the current causes it to deposit the heavier particles of sand on the stream side of the fence, the finer particles being carried beyond it. In this way, each rise serves to heighten the banks now forming, as well as to raise the level of the surrounding country."

In a very short time it is found that the stakes are completely embedded in the deposit which forms around them and spreads out over the area on both sides, so that considerable tracts are reclaimed for cultivation. When the first row of stakes are buried, a second row may be driven, but this is not often necessary. The river banks continue to accrete until the stream has formed for itself a channel large enough to contain practically the whole of its normal flood water (Fig. 3).

Although eminently successful under the conditions obtaining in Burma, it obviously does not follow that such training methods are of universal application. There are manifest limitations to their serviceability. They are essentially suitable in the case of streams originating as hillside torrents, and heavily charged with detritus and sandy silt; and then, chiefly, in their upper reaches. Considerable variation in water level and frequent overtopping of banks in the early stages are features of the course of channel formation, and when these characteristics are lacking, the method cannot be utilised, or, at any rate, not so effectively or with such striking results.

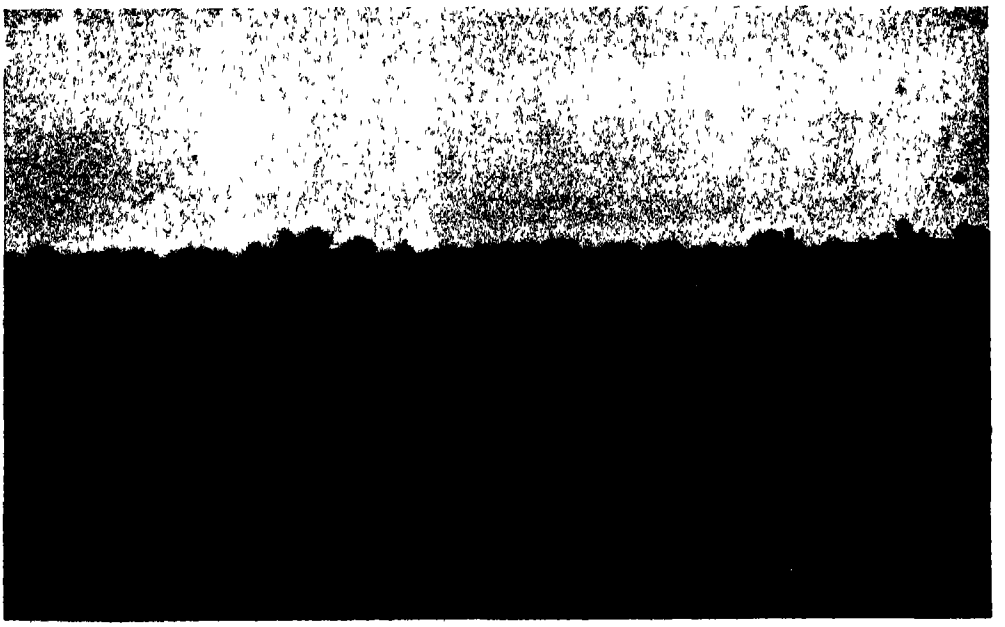


FIG. 3.—Shwele stream. 8 ft. banks only 3 years old *Laka* water can be seen behind.
From "Regulation of Rivers without Embankments."

The process is, however, certainly a notable step in the development of the science of channel training, and further experience in its use will be watched with interest. The volume which we have had under review gives much local information of a helpful character to river engineers desirous of employing the method elsewhere, under conditions similar to those obtaining in Burma. There are ten maps, nine diagrams, and an abundance of photographs.

BRYSSON CUNNINGHAM.

Anthropology of African Tribes.

(1) *The Vanishing Tribes of Kenya: a Description of the Manners and Customs of the Primitive and Interesting Tribes dwelling on the Vast Southern Slopes of Mount Kenya, and their Fast Disappearing Native Methods of Life.* By Major G. St. J. Orde Browne. Pp. 284+16 plates. (London: Seeley, Service and Co., Ltd., 1925.) 21*s.* net.

(2) *On the Trail of the Bushongo: an Account of a Remarkable and hitherto Unknown African People, their Origin, Art, High Social and Political Organisation and Culture, derived from the Author's Personal Experience amongst them.* By E. Torday. Pp. 286+16 plates. (London: Seeley, Service and Co., Ltd., 1925.) 21*s.* net.

(3) *Fresh Tracks in the Belgian Congo · from the Uganda Border to the Mouth of the Congo.* By Hermann Norden Pp. 303+30 plates+2 maps. (London · Witherby and Co., 1924.) 18*s.* net.

THE three books under notice all indicate the extraordinary rate of change that is taking place in Africa. Though Mr. Norden may be inclined to see "a step towards Utopia" in a Belgian industrial plantation, most thoughtful observers are alarmed by the effect of industrialism on black Africa. Mr. Norden noticed that, whereas his belongings had never been pilfered in the wilder parts of the Congo, when he approached "civilisation" locks became necessary. That, of course, is nothing when compared to the break-down of tribal custom and belief, with its accompanying loss of control which follows so quickly on contact with Europeans. Major Orde Browne is acutely aware of this grave danger, so that his book, (1) "The Vanishing Tribes of Kenya," will be of value to all who have to deal with natives either as government officials, missionaries, or settlers. What he has to say on the brideprice, initiation, trial by ordeal and government, is all eminently sound. His book is a careful, though not exhaustive, study of the tribes on the south-east slopes of Mt. Kenya, the Embu, Emberre, Mwimbe, and Chuka; all these tribes have suffered much influence from and admixture with the Meru, Akikuyu, and Akamba, but the Chuka are the most distinct stock and the least touched by foreign influence. As this is a serious anthropological study, it is to be regretted that a summary of the physical measurements taken has not been given in the book.

In some ways the Chuka seem to be a curiously negative people. They do not remember their own genealogies and have very little knowledge of their history. These two deficiencies are accounted for by their customs and beliefs. They have no chiefs, the government being vested in councils of elders similar to those of the Masai, though war leaders, through their personal prowess, may gain considerable eminence. Major Orde Browne says that there is no belief in a survival of any kind after death; he records no trace of ancestor worship; and corpses are left to be devoured by hyenas. Considering the importance of the ancestral spirit in every department of life among the Akamba and the Akikuyu, and assuming that Major Orde Browne has not been misled, this negative side of Chuka belief may be due to their Meru ancestry. The Meru are related to the Masai, among whom ancestral spirits appear to be relatively unimportant, and only the chiefs are buried. Like the Masai, the Chuka drink blood and milk mixed, but three months must elapse between the eating of meat and the drinking of milk, unless a special berry is taken as a purification. There are no rain-making chiefs, but a certain clan, the Ithaga, who are mostly smiths, are believed to have power over the rain; they also possess particularly potent curses. This gives substance to the statement by Mr. Hobley, who was told that the smiths of the Akikuyu all came originally from Ithanga, on the south side of Mt. Kenya ("Bantu Beliefs and Magic," p. 167). Akikuyu smiths can also inflict powerful curses. The system of *thahu*, ceremonial uncleanliness, which pervades Chuka life, is essentially the same as that of the Akikuyu. A man may become *thahu* for a variety of reasons, many of which seem trivial to the European; in spite of this there is no doubt that tribal morality is dependent on this system, for the most potent weapon of the council of elders is their curse, which renders a man *thahu*. This book is of value and deserves a better index.

(2) Mr. Torday's book will appeal both to the general reader and to the anthropologist. There is plenty of adventure, gaily told; there are stories of cannibals, pigmies, gorillas, and natives who, not having met Europeans before, seemed to have no desire to make their acquaintance. Mr. Torday, however, was of a different mind; he wanted to know the various natives of the Congo, and succeeded in great measure. About fifteen years ago he was the first white man to stay in the Bushongo capital. He made friends with the king, prime minister, and other court officials, including the official historian. His researches into the history of these people disclosed a list of 121 successive kings, and the fact that, during the reign of the 98th, there had been an eclipse of the sun, enabled him to fix the date of that reign at 1680.

The account of these highly organised, peaceful, and industrious people is fascinating; their arts and crafts are probably the finest in Africa. Tall individuals with refined Hamitic features are conspicuous among the aristocrats in general, and especially those of the

royal clan, the Bambala, forming a contrast to the common Bantu population. Tradition relates that the first Bushongo king came from a far country in the north, and that in the journey to their present home the Bushongo crossed four great rivers. Mr. Torday has produced considerable evidence to show that this tradition is correct, and further, that Hamitic invaders from the neighbourhood of Lake Chad came south some time in the sixth century, conquered the Bantu inhabitants, who were closely akin to the Baluba, and founded the Bushongo nation. Mr. Torday saw reason to suppose that, between the Kasai and Loange rivers, he would find among the Bakongo and Bashilele a people similar to the original Bambala, before their admixture with the Baluba. The country had never been visited by white men before and was hostile to strangers; his adventures in this region make good reading, but, on account of the hostility and suspicion aroused, ethnological work was scarcely possible, and he failed to discover the evidence he was seeking. He was, however, rewarded by finding a high percentage among the Bashilele with Hamitic features.

(3) Returning to Mr. Norden's book, we learn that the author travelled from Lake Tanganyika to the Atlantic, and that he stayed in government stations, plantations, missionary stations, mining centres, and native villages, upon all of which he makes remarks with an extreme naïveté. Whereas he was able to make first-hand observations on the government's servants, missionaries, and traders personally, his comments on the natives are culled either from these former, or from the explanations of his boy, Pierre, and suffer accordingly. Thus, of the Bushongo, he states that the Lukango is the king, but the Nyimi is the supreme judge. As a matter of fact, there is no trace of such a division of function, both of which are held by the Nyimi; Lukango is the Balabu title for the Nyimi. The government of this nation was fully investigated by Mr. Torday and published in his "Notes ethnographiques" (Bruxelles, 1910), and it is to be regretted that Mr. Norden has failed to add to our knowledge of these interesting people.

BRENDA Z. SELIGMAN.

Schools of Psycho-Analysis.

Sigmund Freud: his Personality, his Teaching, and his School. By Fritz Wittels. Translated from the German by Eden and Cedar Paul. Pp. 287. (London: G. Allen and Unwin, Ltd., 1924.) 10*s.* 6*d.* net.

THIS critical history of the psycho-analytical movement, as seen from within by Dr. Fritz Wittels, is of necessity, and admittedly, biassed by his own temperament. He describes how five years of friendship with Freud was followed by an estrangement, which, however, has not prevented Freud from acknowledging the merits and pointing out the drawbacks of the book in a letter from which extracts are reproduced as an introduction. A biography is combined with a running criticism of Freud's views as their development is described, and the personal conflicts are traced that led in turn to the secessions of Jung, Adler, and Stekel, for the last of whom the author expresses an admiration which obviously influences his own opinions. The picture he draws of the faithful disciples who will recognise no other authority than Freud, and of the dissentients who became outcasts from the fold, has few likenesses in the history of science. The pioneer psycho-analysts were surely not like other people, and for this a glance at the history of the movement offers explanations. The contumely and abuse that fell upon them ensured the selection of those careless of the opinion of the herd, whilst the slighted herd instinct demanded in turn the formation of a defensive sect. The absence of effective criticism free from emotional bias aided the isolation from, and contempt for, the outer world of science and medicine.

That psycho-analysts have resigned themselves to this condition of affairs is perhaps the most unfortunate outcome of the position. Wittels notes the resemblance between the schisms of the psycho-analytical schools and those of the early Christian sectaries, and in himself carries the resemblance a stage farther. Nothing matters to him except these schisms; no opposition to Freud exists but from the seceders; the world consists of believers and dissenters on one hand, and of Turks, infidels, and heretics on the other, and the latter do not count. That Freud himself did not willingly accept the position is shown by his remarks during the Nuremberg congress in 1909: "It is absolutely essential that I should form ties in the world of general science. I am getting on in years, and am weary of being perpetually attacked."

For the ordinary reader of this book—which gives an outline of Freudian theory as approved by Dr. Wittels—there will be difficulty in separating science from art, observation from deduction, accepted theory from individual speculation, and it is indisputable that the same difficulty will meet him in many books on psycho-analysis. Yet it is desirable that psycho-analysis should be subject to the canons of science, and on p. 54 the author indicates a starting-point at which scientific judgment may be applied. He declares that the psycho-pathologist can find in the unconscious an adequate cause for neurotic anxiety and can demonstrate it to others. The statement is definite, and there are many psycho-pathologists who will support it; that

the primary basis of anxiety is the sex instinct in some pathological development is likewise a question that may be scientifically approached in an atmosphere free from the dust of prejudice. The barrier that Dr. Wittels accepts as part of the natural order of things must be broken down in the interests of science and medicine as well as of psycho-analysis. M. C.

Our Bookshelf.

Bituminous Substances · Scientific Progress of Practical Importance during the last Fifteen Years. By Dr. Percy Edwin Spielmann. Pp xvi+206+8 plates. (London · Ernest Benn, Ltd., 1925) 15*s* net.

BITUMINOUS substances are here interpreted as "asphalt" in its varied form and utilisation, but the treatment of the subject is essentially physico-chemical, wherein this volume differs as a text-book from its predecessors

The complexity of the chemistry of petroleum, more particularly its products of high boiling point and molecular weight, is well known, but the chemistry of asphalt is the least understood of all. For this reason it was a bold effort to compound in a small volume the essence of our knowledge, so far as it has progressed, of the constitution, properties, effects of heat, ageing and solvents, critical physical and chemical tests and behaviour under diverse experimental and practical conditions, of this remarkable substance From the earliest times (according to the author, 12,000 years ago) there are isolated references to the utilisation of bitumen in the service of man, chiefly as an adhesive material; history further shows that throughout the progress of civilisation, man availed himself of this natural product without in the least understanding its true nature and composition To-day we recognise extended uses of bitumen, but theory still lags far behind practice, and our knowledge of its chemistry, as indeed our methods of investigating it, are mainly empirical, if not actually arbitrary

In "Genesis of Petroleum" the author revealed his knack of extracting successfully the pith of published work from many sources (often inaccessible to most people), and of presenting it in the form of a coherent summary of progress; in the present work he does much the same thing, supplementing data thus obtained with results of personal research and that of his former colleagues. One cannot but welcome a book of this description, even though it must be regarded as an interim report and be subject to the limitations of such publications. H. B. M.

Money Scales and Weights By T. Sheppard and J. F. Musham. Pp. vi+221. (Hull: A. Brown and Sons, Ltd.; London: A. Brown and Sons, Ltd.; Spink and Son, Ltd., 1924) 10*s*. 6*d*.

THE versatile curator of the Hull Museums has collated in this volume the notes on coin scales and weights—mainly with reference to the unique collection in his charge—which have appeared during recent years in the *Numismatic Circular*, together with a few addenda. Mr. Musham has added a descriptive catalogue of the comprehensive series of English coin weights collected by him and acquired by the Hull Corporation. The result should be of interest to the collector and the antiquary. As a reference work, however, its usefulness would be much enhanced by the addition of a general index and a bibliography and by a careful editorial revision. One would expect the scales to be grouped according to their principles of construction, whereas the *fundamentum divisionis* that has been selected is the structure and decoration of their cases. The descriptions of the various scales are disparate and contain much needless repetition. Dates are sometimes assigned without any apparent evidence; the balance described under No. 151 is given the date 1765, but the patent for it was not granted until 1774. The word "crescentric" is persistently used for "crescentic."

A chat with a practical scale-maker would have facilitated clearer description and obviated, for example, the use of the term "oil-caps" for balance bearings (pp. 75, 79, etc.). The importance of the nature of these bearings does not seem to have been grasped, nor is investigation made as to the probable degree of accuracy with which the instruments may have fulfilled their functions. The illustrations are copious and good, but the explanatory diagram on p. 31 suffers from excessive reduction.

Text-book of Cellulose Chemistry. for Students in Technical Schools and Universities as well as for Cellulose Experts By Prof Emil Heuser Translated from the second German edition by Clarence J. West and Gustavus J. Esselen, Jr. Pp xi+212. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 12*s*. 6*d* net.

THE literature of the chemistry of cellulose is prodigious in quantity and very variable in quality, and bits of it may be found in anything from treatises on tropical agriculture to the prospectuses and reports of limited liability companies. Attempts have been made to collect it all between one pair of covers, but these have mostly resulted in tomes for reference rather than in books for students. With the development of technical education it has apparently been found necessary to teach students connected with the textile, paper, and other industries something about the chemistry of their common raw material—cellulose—and hence the demand for a text-book such as that under review.

Bearing in mind the extent and character of the literature to be dealt with, Prof. Heuser has been remarkably successful in bringing the data into some sort of order and compressing them into reasonable compass. British chemists will, however, be somewhat surprised to find how small a part the British contribution to knowledge of the chemistry of cellulose, both on the scientific and the technical sides, plays in Prof. Heuser's story. This feature of the book seems to have struck the translators, and in the chapter on the constitution of cellulose they have felt it necessary to insert a note describing some of the very important work on this subject done by Hibbert in the United States and by Irvine and his collaborators in Great Britain. Work on cellulose esters is so voluminous that the author is perhaps not unreasonable in devoting 47 pages to it and only 8 to cellulose ethers, though the latter may be much more important in their bearing on the constitution of cellulose than the former. T. A. H.

The Psychology of the Unadjusted School Child. By Dr. John J. B. Morgan. Pp. xi+300. (New York: The Macmillan Co., 1924.) 9*s.* net.

THIS is a valuable addition to the literature of the psychology of education and should be read with great profit not only by professional psychologists and teachers, but also by every one who is interested in that most artistic of the arts—character-building The work is, in a sense, a study of individual differences that are emphasised almost to the point of being abnormalities, and an attempt to trace these to their causes.

After a section discussing the nature of mental disturbances, five sections follow in which various ways of adjustment or mal-adjustment with reality are lucidly, simply, and accurately sketched out There is the direct struggle and compromise with reality in its various forms. This is treated in some detail, and always with practical and useful suggestions for the teacher or parent as to how the growing mind should be helped in its process of adjustment, and not hindered, as is often the case—even up to the point of fostering mal-adjustment—by the treatment it receives at their hands. Section VII. contains a chapter upon the prevention of abnormalities of character. This is not, and cannot be in the present state of our knowledge, final or exhaustive; but it is all on the right lines, and follows such principles as have already been established by psychology.

The main conclusion which is reached by Dr Morgan is that, since education is not merely the imparting of information, but also the formation of character, it is not the technique of teaching, but an understanding of human nature which can only be obtained by studying mal-adjustments that is needed by the teacher. Conflicts begin early in life; and mal-adjustments take root and grow readily. To prevent them, or to root them out before they have had time to consolidate themselves, is really the highest privilege of the teaching profession, a privilege which the teacher should understand how to exercise.

Fundamentals of Vocational Psychology. By Prof. Charles H. Griffitts. Pp. xiii+372 (New York: The Macmillan Co., 1924.) 12*s.* net.

THE problem of vocational guidance is that of ascertaining the special aptitudes of any individual for a given trade or profession. Accordingly its solution lies in a study of individual differences in such a way that they may be practically determined in any given case. Much attention has been given by psychologists to this matter of late, and Prof. Griffitts' book contains an excellent presentation of vocational psychology so far as it has been yet worked out. Physiognomy is discussed at great length as an indication of aptitudes; but the conclusion is reached that inferences from it are of little validity, and the interview is emphasised as the best guide in the selection of employees and, generally, in vocational advising. The psychological aspects of the interview are carefully presented, and rating scales with regard to character dealt with. As supplementary to the interview, tests are recommended as "devices which under certain conditions give results which are valuable to the interviewer."

It will be seen that the author is not one of those who expect everything from tests in the present immature state of this department of applied psychology. Indeed, he recommends great caution in their use. A number of tests are given in detail as to methods and technique; but the reader is reminded that there can be no applied psychology without a background of sound theory, and, in consequence, general psychological principles are emphasised throughout.

Rejuvenation: the Work of Steinach, Voronoff, and Others. By Norman Haire. Pp. 223 + 2 plates. (London: G. Allen and Unwin, Ltd., 1924.) 7*s.* 6*d.* net.

THE author set himself the task of writing a book that should make the subject of rejuvenation intelligible to the educated layman and yet be sufficiently technical to satisfy the medical reader in search of a general statement of the subject. He has succeeded in his attempt. The book can be recommended to those to whom it is addressed. A layman seriously seeking information will find in it a fair statement of the facts concerning the operative methods by which rejuvenation is attempted and a trustworthy analysis of the results of the work that has already been done in this particular field. Its great value to the medical man is that it gives a review of the whole subject and guides one to deeper reading.

A very complete list is given of the recorded cases, both in animals and man, and the relative merits of vasoligature, gonad implantation and irradiation are discussed. The American and Continental literature has been well searched and the records tested against the author's own case-histories The author points out that the earlier reports emphasise specially the sexual rejuvenation, and maintains that in the human beings this is by no means the most important or most striking result of the operation.

The Extra Pharmacopœia of Martindale and Westcott. Revised by Dr. W. Harrison Martindale and W. Wynn Westcott. Eighteenth edition, in 2 vols Vol. I. Pp. xxxviii+1163. (London: H K. Lewis and Co., Ltd., 1924) 27*s.* 6*d* net.

THIS book is well known to all British pharmacists and medical men, and the frequency with which new editions have to be issued is sufficient indication of its trustworthiness as a work of reference to the enormous number of drugs, chemicals, and ingenious combinations of these now used in medicine It is more than four years since the last edition was published. In the interval, many advances have been made in the treatment of disease, and the authors have shown their usual skill in selecting from the pharmaceutical and medical literature that accumulates during such a period those items that are likely to be of permanent value. While full attention is given in the new edition to such important subjects as the use of insulin in diabetes, the treatment of syphilis with preparations of bismuth, new synthetic remedies for trypanosomiasis, and new methods of dealing with leprosy, the numerous small advances in medicine and pharmacy by which constant progress of a less striking character is being made, are not neglected.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Ether-drift and the Relativity Theory.

THE brief messages in the daily press with regard to Prof. D. C. Miller's experiment have aroused much interest and bewilderment; it is therefore of great value to have Dr Silberstein's authoritative account in NATURE for May 23. Comment on the experiments themselves would be out of place until the details are published; but it may not be premature to point out that the surprising hypothesis of ether-drift, by which it is proposed to account for the results, is disproved in advance by the daily measurements at astronomical observatories These measurements constitute a test for differential ether-drift much more delicate than the Michelson-Morley experiment

According to Dr. Silberstein's summary, the ether is gliding over the earth at a speed which increases from about zero at ordinary ground-level to 10 km. per sec. at the summit of Mt Wilson. There is thus a rapid rotational motion of this part of the ether. So early as 1845, Sir George Stokes showed that in order to conform with the astronomical facts of aberration the motion (if any) of the ether must be *irrotational*

The difficulty is seen vividly if we consider the curvature of a ray of light coming to us from a star, taking account of this ether-flow A ray which is vertical at the summit of Mt. Wilson will on reaching sea-level have an inclination of 7″. Thus observations of absolute star-position at mountain observatories and at sea-level will be discordant by amounts of this order. An error of the order 7″, variable according to the time of day, would play havoc with fundamental astronomy.

The Michelson-Morley experiment was originally performed because it was thought—mistakenly, as we now realise—that it would measure *absolute* ether-drift For many years it was in sole possession of this field of inquiry. In the new application to *differential* ether-drift it is invading a field in which the facts have long been established by delicate observations, and it is difficult to regard it as a serious competitor.

A. S. EDDINGTON.

Observatory, Cambridge,
May 25.

The Faraday Benzene Centenary.

IN a recent letter (NATURE, April 18), I ventured to counsel chemists to go back to the land—to study Faraday. Since then, in the *Times* (May 16), I have urged that Faraday's great discovery of benzene, one hundred years ago, should henceforth be commemorated on June 16, the day on which it was communicated to the Royal Society of London. Surely we should make this a saint's day in our chemical calendar. The public has its Saint Lubbock's days, for the mere purpose of resting from its labours—in days when labour is beginning to be regarded as a work of supererogation. Why not a chemists' rest-day for the purpose of contemplation: to give emphasis to our recognition of the importance of Faraday's discovery and its astounding consequences: more particularly, as an outward and visible sign of our belief in the method we wield in our search for truth?

As an analytical achievement and as an astounding demonstration of the power of the human intellect to penetrate into the mysteries of matter, the great benzene chapter in organic chemistry, built upon the foundations Faraday laid, may be ranked above all others. It is for chemists to show that our science of chemistry has a mission in society—to make, at least, its simple principles understood. This we must do, if workers in any way believe that the method they wield is of moral significance and not a mere means of dissecting Nature.

It is clear that the politicians are not with us and that even industry has but a half-hearted belief in our ability to serve it. That the public do not understand us is certain Our nation is behind other nations in appreciation of the work done by the scientific inquirer and its value to society. An occasion like the approaching centenary would command wide sympathy abroad but ordinary engagements will come before it with our politicians. We owe it to ourselves to break down the barriers of ignorance, there in large measure because of our constant disregard of opportunity and our failure to cultivate public attention and appreciation.

At whatever effort, chemists are called upon to give proof, at the approaching centenary celebrations, that they, at least, can appreciate the spirit in which Faraday led the way in the battle against ignorance, as an exponent of the laboratory method and as a philosopher. The advice he tendered, best studied in his writings and in the striking biography we owe to Bence Jones, is of incomparable value. It were well if we had a book of excerpts of his sayings, to guide us in our moments of weakness and keep us in the straight and ever narrow path of scientific rectitude. The poets have their anthologies: why not the philosophers?

Let us, at least, now show that we are not wanting in public spirit in our own cause.

HENRY E. ARMSTRONG.

Depth-recording with Plankton-nets.

THE concise account given by Mr. F. S. Russell in NATURE of April 25, of the behaviour of ring-trawl nets when towed, enables an attempt to be made to solve the paradox of his diagrams. The shape of the warp during each haul may be compared with an imaginary catenary of reference. For this purpose the resistance of the net may be replaced by a horizontal force acting at the lowest point of an imaginary warp constituting a true catenary, and use may be made of Mr. Russell's observation that it is the practice to keep the angle of entry of the warp into the water constant at 40° With a constant angle of 40°, the ratio of *bight* to *dip* of a true catenary is 5·4954, and the ratio of *span* to *dip* is 4·9955, bight and span being measured between supports at a common level. In terms of these two constants, and of the particulars of the wire-rope, may be calculated the tension at the winch, the tension at the lowest point of the catenary, and the resistance of the warp through the water. Moreover, from the given particulars of the net an estimate may be made of its resistance for any required speed. Then, by equating the expression for this resistance, to the tension at the lowest point of the catenary, the speed through the water may be estimated. At high speeds there would be disturbances; but as Mr. Russell states that the engine was run "dead slow," there is sufficient probability of an approach to a solution that will not encroach too far into the region of piscatorial credulity, to justify this method of interpretation.

From the dimensions given on p. 603, the resistance of the net may be judged to be about 68 K^2 lb., and the resistance of the 2-in steel-wire rope to be about 0 76 K^2 lb. per fathom, where K is knots In the table, the results of the calculations are arranged in the same order as the hauls in Mr. Russell's diagrams, Figs. 1, 2, and 3 here repeated.

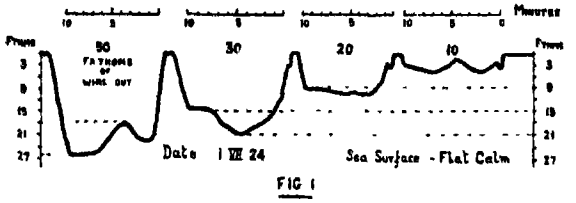


FIG 1

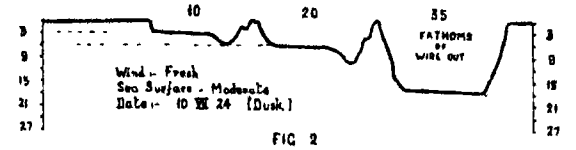


FIG 2

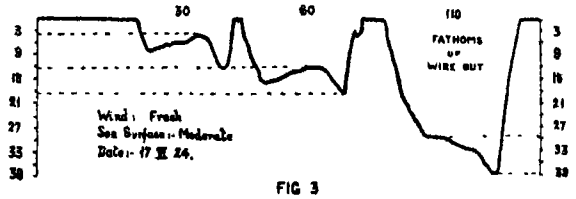


FIG 3

FIGS 1, 2, and 3 are tracings of records obtained during three series of hauls. Each haul, represented by a curve, is of ten minutes' duration (time of "shooting" and "hauling" not included). The net enters the water on the right-hand side of each curve. Above the curve for each haul is inserted the length of wire used, in fathoms

instrument for recording depths was working perfectly Consequently the anomalies referred to by Mr Russell are to be attributed primarily to variations of speed throughout a haul. At low speeds these changes of speed are probably large compared with the speeds. There were also changes of angle. Column 10 is only a rough estimate, but the general character of the warp-resistance is demonstrated.

If further tests are carried out, it might be possible to obtain direct measurements of tension at the winch for comparison with Column 6 A note on speeds would also be useful for comparison with Column 8. It would be an easy matter to prepare tables in a similar manner for a useful range of angles and lengths of warp ROLLO APPLEYARD.

April 30

The Origin of Adaptations.

LAST December, before the American Society of Zoologists, Prof M F Guyer delivered an admirably lucid and well-reasoned address entitled "Soma and Germ" Near the end he says (*American Naturalist*, March-April, 1925)

"The fact is that biologists have never yet hit upon an explanation of the marvellous adaptedness of organisms to their environment which does not put a tremendous strain upon our credulity And when we view it with unprejudiced eye it seems to me that the theory which would attribute adaptation to the mere accumulation of such chance variations as happen to be favourable is the most incredible of all. Time and again in the past, according to paleontologists, whenever new possibilities for existence occurred, forms of life admirably adapted to those conditions have come to occupy the new habitat In some way the environment has moulded these new inhabitants to its bounds, and it takes more faith than I personally possess to believe that it has all been done by the negative method of killing off, generation after generation, the non-conformists—those in which the happy accidents, or rather the innumerable interrelated series of accidents, has not occurred"

(1) Length of Warp.	(2) Whole Bight of Catenary.	(3) Calculated Dip. Bight / 5·495	(4) Observed Dip. From Figs 1, 2, and 3	(5) Calculated Whole Span of Catenary. 4 995 × dip.	(6) Calculated Tension at Winch $t = 10\,25 \times$ dip.	(7) Calculated Tension at lowest Point of Warp $t_0 = 7\,86 \times$ dip	(8) Calculated Speed $K = \sqrt{t_0/68}$	(9) Calculated Resistance of Net $68\,k^2 = t_0$	(10) Calculated Resistance of Warp. 0 76 K^2L.
L. Fathoms.	Fathoms.	v Fathoms.	Fathoms	Fathoms.	lb	lb	Knots	lb	lb.
10	20	3·64	1·5 to 7	18·2	37 3	28 6	0 65	28 6	3 2
20	40	7·28	9 to 11	36 4	74·6	57 2	0 92	57 2	12·8
30	60	10·9	15 to 21	54 5	112	85 7	1 12	85·7	28 9
50	100	18·2	18 to 27	90·9	187	143	1 45	143	80 0
35	70	12·7	18	63·4	130	99·8	1·21	99·8	39 3
20	40	7·28	6 to 9	36·4	74·6	57·2	0·92	57·2	8·5
10	20	3·64	3 to 7	18·2	37·3	28·6	0 65	28·6	3·2
110	220	40·0	29 to 39	199·8	410	314	2·15	314	387
60	120	21·8	13 to 19	108·9	223	171	1·58	171	115
30	60	10·9	5 to 13	54 5	112	85·7	1·12	85·7	28 9

Comparing columns 3 and 4, the calculated dips are seen to be in agreement with the corresponding average of the observed dips, except in the third haul, which happens to be also the one singled out by Mr. Russell as an example of a "bad" result. Fortunately, the tenth haul is identical with the third in length of warp, and in this instance the dip indicated by the imaginary catenary, Column 3, is fairly representative of the observed average, Column 4. It may be inferred that the Admiralty

Without disputing the extraordinary importance and interest of Prof. Guyer's researches we may, I think, present certain considerations which should qualify his conclusions. Presumably it is agreed that alterations in the germ-plasm, which find expression in heritable variations, are caused in some manner—that is to say, are part of a connected sequence of events. The question is, whether the causative agents, whatever they may be, are purposeful in the sense of being directly related to the

functional significance of the resulting changes Prof. Guyer appears to think so, because in his view the development of adaptations in so many organisms and in such diverse ways makes any other view too great a strain on credulity

Many others have held similar opinions The distinguished entomologist, the Rev. Wm Kirby, wrote in 1800 :

" This visible world, by types indeed and symbols, declares the same truths, as the bible does by words To make the naturalist a religious man, to turn his attention to the glory of God, that he may declare his works, and in the study of his creatures see the loving kindness of the Lord, may this in some measure be the fruit of my work."

Because scientific men are no longer accustomed to use such phraseology, they overlook the fact that such writers as Kirby were not expressing mere conventional piety, but were stating what they regarded as profound truth properly deducible from their researches The contrary view, that things happened by " chance," was as difficult for them to believe as it is for Prof Guyer No one who thinks deeply can altogether escape convictions of this sort, and the mind is wholly baffled in attempting to connect the higher flights of the human intellect with the ordinarily understood products of metabolism. But while thus confessing sympathy with Prof Guyer, and no less with the Rev Wm Kirby, it may be well to consider " with unprejudiced eye " what are the real findings of palæontology

The recent work of the physicists has enormously increased our estimates of geological time The significance of this for biology has not yet been fully grasped Evolution has been a process of extraordinary slowness Modern work on extinct animals and plants, as shown by their remains, emphasises the amazing permanence of structures Consider first the limited number of fundamental tissues which go to make up animals Then, when we study fossil insects, plants or molluscs, we find indeed great numbers of species, but these developed largely by a sort of shuffling of characters, with surprisingly little that is new even in millions of years Mammals have evolved much more rapidly, yet we who contemplate the results are always prone to speed up mentally the process, after the fashion of the cinema Palæontology also teaches that innumerable forms have failed to become adapted, and have died only locally or entirely In short " admirably adapted " species have *not* appeared " whenever new possibilities for existence occurred," but have developed here and there, during vast periods of time, naturally accumulating on the earth and filling it with beings whose origin baffles our imagination In the long run, and at the sacrifice of innumerable lives, Nature scores an amazing success, but our impatient thought cannot tediously follow the process The contrary view, that the germplasm is permanently altered as easily and significantly as Dr. Guyer seems to postulate, is the one which strains our credulity, because it should apparently give us modifications far more rapid and purposeful than the observed facts indicate T D A. COCKERELL.

University of Colorado,
Boulder, March 17

The Jet-wave Accelerometer.

IN the issue of NATURE of April 11, p. 530, Prof. Paul Kirkpatrick has, under the heading " Absolute Seismometry . a New Method," described a device in which a liquid jet is used for the recording of the motion of a body

A similar apparatus, the jet-wave accelerometer, has during the last year been studied in my laboratory. I think I may, therefore, be able to throw some light on the subject in question, and especially on the problem : What is actually recorded by the jet ? I may mention that it was a paper by Prof. K. Prytz, " L'accélération mesurée au moyen d'une flamme " (*Le Journal de Physique et le Radium*, Sér. 6, 4, 1923), which caused me to take up the investigations on the jet-wave accelerometer eighteen months ago. It occurred to me that the flame used by Prof. Prytz might be considered as a jet, and that consequently a liquid-jet might be utilised for the same purpose as the flame.

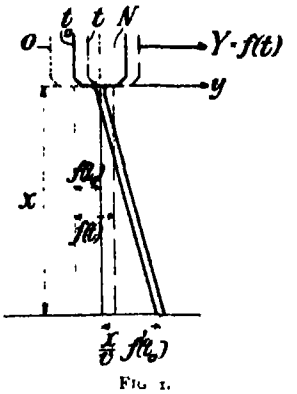


FIG. 1.

When a perpendicular jet is attached to a body moving to and fro in a horizontal direction, we may ask, *What is recorded by the relative deflexion of the jet at a certain distance x from the jet-hole ?* It may easily be shown that, when x is sufficiently small, the *acceleration* of the body is recorded, while at greater distances the *velocity* of the body is traced.

The first statement may be proved in the following way. If the motion of the nozzle N (Fig. 1) is represented by

$$Y = f(t) \quad . \quad . \quad . \quad . \quad . \quad (1),$$

the velocity is $f'(t)$ and the acceleration $f''(t)$. In order to calculate the relative motion of any jet-particle, say the particle which leaves the nozzle at the moment t_0, we have to apply the relative acceleration $-f''(t)$ to the particle. If the deflexion is observed at so short a distance x from the nozzle that $f''(t)$ does not alter essentially in the time used by the particle to travel through x, then the deflexion y is determined by

$$\frac{d^2y}{dt^2} = -f''(t_0) \quad . \quad . \quad . \quad (2),$$

from which we get

$$y = -\tfrac{1}{2}(t-t_0)^2 f''(t_0) = -\tfrac{1}{2}\left(\frac{x}{v}\right)^2 f''\left(t-\frac{x}{v}\right) \quad . \quad (3),$$

v being the velocity of the jet. Thus, y records the acceleration with a delay of x/v, *i.e.* the time for the particle to move from the nozzle out to the distance x.

The second statement above is directly verified by an inspection of Fig. 1. From this figure it is seen that the deflexion at any distance x is given by

$$y = \frac{x}{v} f'(t_0) - [f(t) - f(t_0)] \quad . \quad . \quad . \quad (4).$$

When the deflexion is due to a vibratory motion, the quantity $[f(t) - f(t_0)]$ will ultimately, as x increases, become insignificant compared to $\frac{x}{v} f'(t_0)$, and then the deflexion may be written

$$y = \frac{x}{v} \cdot f'(t_0) = \frac{x}{v} f'\left(t-\frac{x}{v}\right).$$

The deflexion thus records the velocity $f'(t)$ with a delay x/v.

In Fig. 2, θ denotes the variation with time of the angular deflexion of a pendulum, with a period of about 3·3 sec., while y represents the relative deflexion of a water-jet attached to the pendulum and *sheltered* against the air-resistance. The deflexion was considered 9 cm. below the nozzle, and the level of the

water in the reservoir was 2 cm. above the nozzle. The y-curve was calculated from all the relative accelerations acting on the jet, *i.e.* the radial, the tangential, and the Coriolis acceleration. By means of a device which cannot be described in this paper, the moment of the passing through zero of the jet and the amplitude of the oscillations of the jet could be observed with a fair degree of certainty. The observations fell within the intervals indicated in the figure

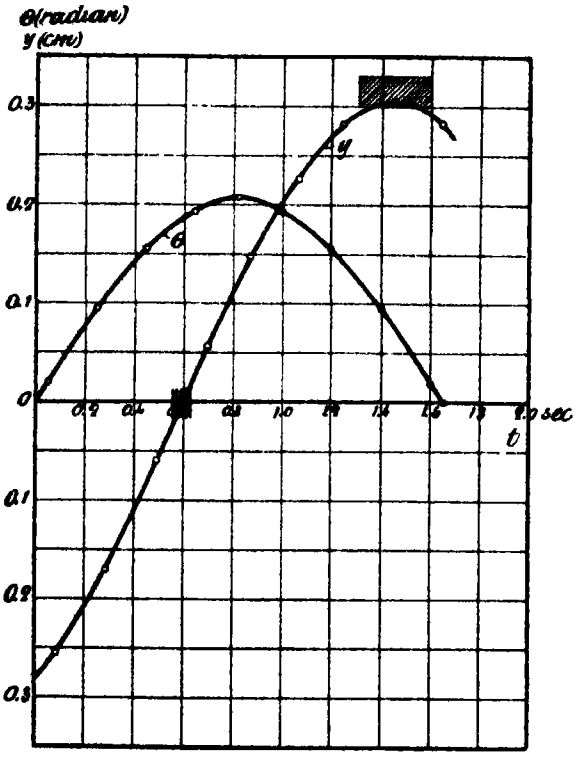


FIG. 2

by hatching and thus closely confirm the theory. It should especially be noted that the observed amplitude agrees with the calculated. This means that the jet-wave recording the acceleration does not show any damping, a fact which was anticipated from earlier experiences with the jet-wave.

JUL HARTMANN.

Physical Laboratory II.,
The Royal Technical College,
Copenhagen, April 16.

The Origin of the Continents.

DR. R. H. RASTALL'S interesting article in NATURE of May 2, p. 646, raises what is perhaps the most difficult problem or group of problems that geophysicists have yet to solve. In considering the origin of the continents, the essential points to be explained are the restriction of the continental blocks to little more than one-third of the earth's surface and the marked asymmetry of their distribution. The formerly popular "tetrahedral" hypothesis, apart from its descriptive inadequacy, has hitherto failed hopelessly when confronted with the principle of isostasy. It clearly implies a process of lateral differentiation whereby the earth's store of granite could become strongly concentrated at the corners and along the edges of the alleged tetrahedron, leaving the interior of the faces, corresponding to the oceanic areas, substantially free from granite Otherwise the tetrahedral form would be unstable and therefore temporary. No one, however, has succeeded in devising any workable process arising out of the earth's contraction which would lead to such lateral concentration of the continental rocks

The absence of a granitic crust from two-thirds of the earth's surface has often been correlated vaguely with the separation of the moon from the earth, but generally on the assumption that before separation took place the granitic crust not only existed, but was also uniformly distributed Even if the earth lost two-thirds of its crust to the moon, the part retained would not remain in one hemisphere. Jeans has shown conclusively that if a thin crust floating on a liquid interior had ever been restricted to one side, it would break up and spread until the blocks were evenly spaced over the whole surface

It is, however, highly improbable that a granitic crust ever existed as such while the more basic underlying materials were still liquid It is much more in accordance with modern petrological ideas to consider that the constituents of granite (together with a large proportion of the water of the existing oceans) would remain fluid for some time after the bulk of the basic material beneath had solidified On this alternative assumption I recently put forward the following suggestions in an attempt to explain the initial restriction of the continents (*Mining Magazine*, February 1925, p. 95) It seems most probable that the first solid silicate material to form would have the composition of peridotite and would accumulate at a great depth. Lying beneath it would be, presumably, the immiscible metallic core; and floating above it the still fluid magma from which more ultrabasic material and the whole of the basaltic and granitic materials were yet to be differentiated. After the separation of the moon the core of the earth would be relatively displaced to one side, and the magmatic ocean would therefore become deeper on one hemisphere than the other At a later stage, when basaltic material had solidified, the residual magma would be granitic in composition, and this would continue to be confined to one hemisphere, provided that the viscosity of the interior had been high enough to prevent the displaced core from becoming central within the time then elapsed since the birth of the moon If, finally, the granite solidified before the core attained a stable position, then a permanent departure from sphericity would be established The earth would thus have had from the first a depressed heavy "Pacific" area, and a broad continental area standing high in virtue of the lower specific gravity of its rocks

Dr Jeffreys tells me that if the internal viscosity had been sufficiently high to retard the recovery of the displaced core to the extent required by the above suggestions, then it becomes increasingly doubtful whether the moon could have separated according to the resonance theory. It is possible, however, that an alternative mode of origin for the moon may be found, and that it may not be necessary to abandon the possibilities arising from a displaced core

It will be noticed that neither the "stripping off" nor the "displaced core" hypothesis gives a distribution of the continental masses corresponding to that which now exists. The one distribution is too dispersed, the other too circumscribed But in neither case need this alone be regarded as a necessary defect. Interest in the Wegener hypothesis of continental drift has made familiar the conception of lateral movements, and that these may be intermittently possible must now be seriously considered in view of Joly's theory of a periodic fusion and solidification of sub-crustal magma due to the accumulation of

radio-thermal energy. The actual distribution of the continents may therefore be the result of their geological history. Their lateral restriction presents a more fundamental problem, and if it cannot be correlated with the birth or former proximity of the moon, it will be difficult to discover any other external constraint capable of providing an explanation

ARTHUR HOLMES

Department of Science,
University of Durham,
South Road, Durham
May 5

The Cresswell Engravings.

THE account in NATURE of May 2, p 658, of the excavations at Cresswell Crags, and the discovery of engraved bones, calls for some comment from me as being the first to cast doubt on the authenticity of the engravings. Some time ago, and before the meeting, I expressed the opinion to my fellow cave-worker, Mr A Leslie Armstrong, that the markings

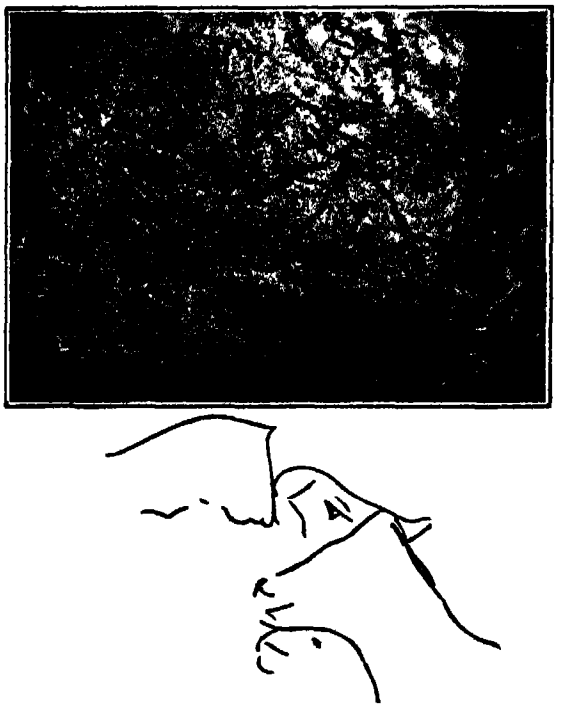


FIG 1.—Portion of an eroded human skull, with (below) tracing made to show animal heads by outlining some of the eroded grooves.

on the three bone fragments from Mother Grundy's Parlour were due to the action of roots I also told him it was a mistake to outline the figures in chinese white. At a later date the bones were submitted to Sir William Boyd Dawkins and he brought them in to me for an opinion I was able to convince him, by means of similarly marked bones in the Manchester Museum from excavations of various dates, that, beyond the two convergent incised lines on the "rhinoceros" piece, the markings on the three bone fragments were due entirely to root-action and were not of human origin

The most convincing piece of evidence is a human skull from a tumulus near Holyhead The outer surface of this skull is scored in all directions by characteristic half-tunnels formed by the action of roots, and it is quite easy by following certain of the grooves to make animal figures of them The accompanying photograph (Fig. 1) shows a small portion of this eroded surface, slightly above natural size. I cannot see the slightest difference between the markings on this skull and those on the three Cresswell bones. The misinterpretation placed upon the markings on the latter mars what is otherwise an important piece of work I can speak with some knowledge about Mr. Armstrong's skill as a cave-digger.

The Pin Hole example is a genuine artifact and is of ivory, as reported to Mr. Armstrong and to Sir William Boyd Dawkins. It has been engraved with a conventional pattern by human agency, and contrasts strongly with the three bone fragments from Mother Grundy's Parlour.

It should be pointed out that the Mills mentioned in the previous account should be Mello.

J WILFRID JACKSON.
Manchester Museum, Manchester,
May 12.

Effect of High Tension Electric Fields upon the Discharge of Locomotive Gases.

OWING to the simultaneous use of steam and electricity on the Swiss railways during the process of gradual electrification, a curious physical phenomenon is seen when the mixture of smoke and vapour from a steam locomotive comes within the electric field produced by the overhead conductors, which operate at a pressure of 15,000 volts, and a periodicity of 17 per second

Under certain conditions the smoke and steam particles are seen to be in violent agitation, very rapid and rhythmical The phenomenon is not readily observed, the special conditions requisite for its production being realised only on rare occasions. It is not observable in the compact white clouds sent out by a heavily loaded locomotive, nor during the emission of dark smoke just after firing; neither is it seen during the heavy discharge from a locomotive while starting a train The most favourable conditions appear to occur during periods of minimum discharge of steam and smoke, when the singular palpitation suddenly appears and just as quickly disappears

Owing to the fugitive nature of the phenomenon it is difficult to count the number of palpitations, but they are certainly of the same order as the alternations in electric tension. This and the requisite attenuation of the water droplets seems to indicate an essentially electric origin for the phenomenon. On the other hand, it is evident that the appearance is in no way connected with electrical discharge of the kind frequently seen between clouds in a thunderstorm, because the palpitation is invisible at night.

During the day-time the palpitation is seen most clearly when the discharge from the locomotive appears "dark grey" against a bright background of sky, or when it appears as a white cloud against an overcast sky. Both these conditions point to an alteration in opacity and, correlatively, an albedo of the cloud mass, caused by a series of alternate condensations and re-evaporations occurring in synchronism with the variations in electric field. Apparently, under certain conditions of saturation, a positive charge will favour the formation of drops, whereas a negative charge leads to their disappearance by evaporation in the warm gases.

In order to test the above explanation I attempted an experimental laboratory verification, using a Klingelfuess induction coil which was controlled by a Roget helix dipping in mercury, and breaking the circuit 10 or 12 times per second. The pressure at the terminals reached about 40,000 volts. The spark

gap plate was extended by a metal rod, extending to within a few centimetres of a narrow orifice, through which issued a jet of water vapour from a small boiler. The boiler was heated electrically in order to avoid the production of disturbing ions through combustion.

The steam remained almost invisible so long as the induction coil remained inoperative, but, as soon as the helix interrupter was started and the intermittent electric field established around the metallic rod, the appearance of the steam jet changed, its visibility fluctuating in synchronism with the dipping of the Roget interrupter and with the polarity of the electric field When the vertical rod was positively electrified the phenomenon was strongly marked, but when the conductor was charged negatively the results were not readily observable.

Although this simple experiment did not reproduce fully the conditions obtaining on the electric railway, it illustrates and corroborates the hypothesis of the alternate condensations and rarefactions being caused by the alternating electric field

P L MERCANTON.

Meteorological Office,
Lausanne, Switzerland

Intensities in Band Spectra.

THE correspondence principle alone is not sufficient to determine accurately the intensities of spectral lines for small values of the quantum numbers. But, as recent investigations have shown, it seems that, in the case of multiplets, this is possible with the aid of the rules found by H C Burger and H B. Dorgelo (*Zeit f Phys.*, 23, p 258, 1924), which state that the sum of the intensities of the lines coming from (or going to) a certain level must be proportional to the inner quantum number (= statistical weight) of this level

It is to be expected that these rules will also hold good for band spectra. Some of the results obtained by applying them to the lines of a band are summarised below.

(1) In a band with only a P- and R-branch without fine structure the intensities are, if the statistical weights a priori are $2m-1$, proportional to:

$$\left.\begin{matrix} m \to m+1 & . & me^{-E_m/kT} \\ m+1 \to m & : & me^{-E_{m+1}/kT} \end{matrix}\right\} \quad . \quad . \quad (1)$$

For small rotational quantum numbers the intensities are symmetrical with respect to the missing zero line

(2) The P-branch is somewhat more intensive than the R-branch, the quotient for the two maxima being $e^{\sqrt{2}\sigma}$, if the rotational energy can be represented by $E_m = \frac{h^2}{8\pi^2 J} m^2$, and we put $\frac{h^2}{8\pi^2 JkT} = \sigma$.

(3) If the band lines are non-resolved doublets as, for example, in the CN-bands, the intensity distribution must be another one, as in the case of true simple lines. With the interpretation of the fine structure given by A. Kratzer (*Ann. d Phys.*, 71, p. 72, 1923), or an alternative one proposed by the present writer (*Physica*, 5, 1925), the factor m in (1) must be changed by $2m-1$.

(4) In such bands as the CN-bands, one or more lines in the neighbourhood of the zero line are simple instead of unresolved doublets. Such lines are not weaker than would be expected from the neighbouring lines, but have the normal intensity.

(5) There are some possibilities which give alternating intensities, as observed, for example, in the nitrogen and hydrogen bands.

Equation (1) is the same as that found by E. C. Kemble (*Phys. Rev.*, 25, p. 1, 1925) in removing the degeneration of the two rotational degrees of freedom by an external field and applying the correspondence principle to the non-degenerated system. Such a procedure gives a better approximation to the true intensities also in the case of a multiplet, as was shown by E. Fermi (*Physica*, 4, p. 340, 1924), but it remains an approximation. Besides, it is necessary to know how the system behaves in an external field, and as to molecules we know nothing certain about this point.

Accurate quantitative measurements of intensities of band lines do not exist. The results are, however, in good qualitative agreement with the observations. If an application of the rules of Burger and Dorgelo to band lines is justified, intensity measurements will be of very great value in determining the structure of band spectra

A more detailed account will be given elsewhere.

G H DIEKE.

Instituut voor theoretische natuurkunde,
Leyden, April 27

The Word "Australopithecus" and Others.

IT has been stated by several critics that the word "Australopithecus" is a hybrid (Latin-Greek) term I am indebted to my colleague Mr T J Haarhoff, professor of classics in the University of the Witwatersrand, for the information that *pithecus* was a recognised naturalised Latin word in Rome It was used by Cicero's own secretary Tiro and by other accredited writers, and more than a century before Cicero's time Plautus employed the diminutive *pithecium* It is, therefore, not surprising that both of these words are to be found in a standard Latin dictionary, such as that of Lewis and Short The still commoner *cercopithecus* is found in Pliny, Varro, Juvenal and Martial, to the last-named of whom (Book xiv. Epigram 202) we owe one of the most pleasing examples of the indiscriminate juxtaposition of the two words used by polished Romans for a monkey:

Callidus emissas eludere simius hastas
Si mihi cauda foret cercopithecus eram

"A monkey, cunning to avoid darts, hurled at me (the charge that)
I should be a tailed ape, had I a tail"

With regard to Homosimiidae versus Hominisimiidae, surely the word is parallel with any other double nominal term such as Pithecanthropus or Anthropopithecus In defence of the introduction of the term Homosimiidae instead of Australopithecidae little need be said since the group intermediate between true apes and true men must have been manapes and not all necessarily, much as one may anticipate the discovery, southern-apes.

RAYMOND A. DART.

Photo-electric Cells for Colour-matching.

I NOTICE in your description of the exhibits at the Royal Society Conversazione in NATURE of May 23, p. 820, a brief mention of the method of colour-matching lamps by means of alkali photo-electric cells, shown by the National Physical Laboratory. As stated in the programme of the Conversazione, this method of colour-matching was first developed by the staff of the Research Laboratory of the General Electric Co., who kindly made for us the cells used, which are now being shown in the Royal Society's exhibit at the British Empire Exhibition. I shall be glad if you will allow me the opportunity of making this acknowledgment in your columns.

J. E PETAVEL,
Director.

The National Physical Laboratory,
Teddington, Middlesex,
May 26.

The Cooling of the Earth.[1]

By Dr. HAROLD JEFFREYS, F.R.S.

THERE are strong reasons for believing that the earth was wholly fluid at an early stage of its history. My present topic is the manner in which such a fluid earth would solidify and afterwards cool to its present state.

The best known account of the solidification of the earth is that given by Kelvin. Most of the rocks that constitute the crust contract when they solidify. According to Kelvin, then, the first stage in solidification was the formation of a thin solid shell on the outside. But this shell was denser than the liquid interior, and therefore was unstable when floating on it. The shell therefore broke up and the pieces sank. A new shell then formed on the outside and the process was repeated, until the liquid was replaced by a sort of honeycomb; the cells filled with magma might become the seats of later vulcanism.

This account requires to be modified to allow for two facts. Pressure raises the melting point, and also the temperature of a rock material. Also the earth is not composed of a single material, but of several with widely differing densities and melting points We wish to know how far these facts will modify the mechanism described by Kelvin.

Taking the former effect first, let us consider what would be the actual course of events in the solidification of an earth composed of a single rock material and cooling by radiation from the surface. Matter cooling at the surface would thereby contract and become denser than that underneath, and therefore would sink, its place being taken by other matter from below. Thus the whole would be continually stirred up. But when the matter descends it enters regions of greater pressure, and consequently is heated The rise of temperature is estimated by L. H Adams, of the Geophysical Laboratory at Washington, as somewhat less than 1° C. per kilometre of depth. So long as the earth remained fluid, then, the temperature in it would decrease downwards at this rate

Now pressure raises the melting point of rocks to the extent of 3° C. for the pressure due to the weight of a kilometre of rock, much more than the effect of pressure on the actual temperature of a specimen of fluid. Thus, while the earth was fluid, the difference between the temperature of the fluid at any depth, and the melting point at the same depth, was greatest at the surface and least at the bottom. The temperature therefore reached the melting point first at the bottom, and solidification started there (at the centre of the earth, that is, since we are considering an earth of uniform composition). Cooling and agitation continued at higher levels, and the solid layer gradually thickened until it reached the surface. Thus the honeycomb structure would not be produced.

Coming now to the differences of material within the earth, we can exhibit the principal constituents in the accompanying table.

The materials are here arranged in order of increasing density. They probably form fairly continuous layers in the earth, the denser at the greater depths. The first four are frequent at the surface, but the Femi is known only in deep-seated intrusions, and the nickel-iron alloy is only believed to occur deep down in the earth because some such material is necessary to account for the high mean density of this planet. The names Sal, Sima, Femi, and Nife are due to Suess; each combines in abbreviated form the names of two characteristic constituents of the material.

Layer	Typical Rock	Specific Gravity.	Melting Point.	Chief Constituents.
Air		10^{-6}	$-200°$	
Water		1	0°	
Sal	Granite	2 66-2 72	600°-1000°	SiO_2, Al_2O_3
Sima	Diabase, Basalt	3 0	1200°	SiO_2, FeO, CaO, MgO
Femi	Peridotite	3 3	1400°	SiO_2, MgO (in excess), Fe_2O_3, Fe_3O_4
Nife	Nickel-Iron	8 2	?	Ni, Fe

One of the first events in the formation of the earth was the settlement of the Nife to the centre. We know from the theory of the figure of the earth that its boundary is about 1400 km. down, so deep that it can have had no important effect in the evolution of the upper layers

If the water of the ocean was originally in the atmosphere, in the form of steam, the pressure of its vapour at the earth's surface would be of the order of 300 atmospheres. It is known by experiment that at such a pressure melted granite and water mix freely. It is therefore probable that nearly all the water was initially within the crust, dissolved in the rock magmas. It is more doubtful whether the principal rock types could mix with each other when fluid. Experimental evidence shows that they could in some conditions, but their present mode of occurrence indicates that at some stage in the development a certain amount of separation took place. It is probable that a gradual solidification of the denser and less fusible rocks led to a concentration of the water in the granitic layer, and that much of it was extruded from the last itself when it solidified.

The solidification would start either with the Nife or at the bottom of the peridotitic layer, and would extend upwards as was described for a homogeneous earth. The liquid above would remain in adiabatic equilibrium until no further femic material remained liquid. The temperature anywhere in the solid portion would evidently be the melting point at the depth considered. Hence the rate of upward transmission of heat by conduction in the solid layer is calculable: it would be about $1{\cdot}5 \times 10^{-7}$ cal./cm.^{2} sec. But the rate of loss of heat from the outside by radiation would be more like 1 cal./cm.^{2} sec. Thus the liquid layer would go on cooling by radiation almost as if no heat was being conducted into it from below, until the temperature at its base reached the melting point of Sima, when the rocks of this type began to solidify. When the Sima was solid, further cooling led to the solidification of the Sal layer; at some stage of the process the water separated and an ocean formed.

As soon as the earth was solid at the outer surface, the great excess of the heat lost by radiation over that

[1] Based on a lecture delivered before the London Mathematical Society on April 23.

conducted from the interior would ensure that the temperature of the surface rapidly fell until the loss of heat from the surface nearly balanced that received from the sun. The sun was at that time probably radiating about as intensely as at present, so that the equilibrium temperature of the surface would also be nearly the present temperature. Thus the primitive solid earth would have much the same surface temperature as now, but a temperature equal to the melting point of peridotite was reached at, or a little below, the top of the femic layer, perhaps 40 kilometres down. Cooling to this stage probably took some thousands of years from the formation of the earth.

The cooling of the earth, from the stage just described, down to its present condition, was a much slower process. So long as the outer layer was liquid any cooling on the outside would lead to turbulence, and therefore the whole of the liquid layer would cool equally fast. But when the earth had become solid, conduction became the only agency available to redistribute its heat, and conduction is very slow. The beginnings of a quantitative discussion of the point were made by Fourier, who showed that if we have a uniform rod, infinite in both directions, and with initial temperature $f(x)$ at distance x from a fixed point of the rod, the temperature at time t is given by

$$V = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} f(x + 2qh\sqrt{t}) e^{-q^2} dq,$$

where h^2 is the thermometric conductivity. In the earth the region is not infinite in either direction; but it is found to be a good enough approximation to suppose it infinite downwards and to treat the flow of heat as one-dimensional, since the depth where cooling is considerable is a small fraction of the radius. The other boundary condition is that the temperature at the surface is maintained constant. Lord Kelvin made the first important contribution to this problem, as to that of the method of solidification, though in this case also his discussion has needed much revision to bring it into accordance with later experimental knowledge. He supposed the temperature at all depths, 0 to infinity, to be uniform and equal to S, the melting point. The difficulty of the constant surface temperature was met by replacing the earth by a solid infinite in both directions, the temperature being antisymmetrical with regard to the surface. Thus subsequent conduction would keep the surface temperature constant, and Fourier's solution could be applied as it stood.

Kelvin's solution was

$$V = S \operatorname{Erf} \frac{x}{2h\sqrt{t}},$$

the symbols having the meanings already given. Erf is the Error function, defined by

$$\operatorname{Erf} \lambda = \frac{2}{\sqrt{\pi}} \int_0^{\lambda} e^{-q^2} dq.$$

Differentiating this and then putting x zero, he found

$$\left(\frac{\partial V}{\partial x}\right)_{x=0} = \frac{S}{h\sqrt{(\pi t)}}.$$

This equation was used by Kelvin to estimate the age of the earth. The left side is the rate of increase of temperature downwards at the present time, determined from observations in mines and borings. With modern data this is $32^\circ \times 10^{-5}$/cm., and with S equal to 1400° and h as 0·084 c.g.s., the equation makes t equal to 27 million years.

The increase of temperature downwards would alter this equation slightly: its effect is to introduce into the temperature a term of the form mx, which does not change with the time. Allowing for this we find that the estimate of t needs to be increased to 33 million years.

These estimates, however, were found to need drastic alteration soon after the discovery of radium. Radioactive matter was discovered to be universally present in rocks, to such an extent that in an average granite it is generating $10{\cdot}1 \times 10^{-13}$ cal. per c.c. per second; the amount for a basalt is $2{\cdot}7 \times 10^{-13}$ cal. per c.c. per second. These amounts appear small, but then so is the loss of heat from the surface. The latter is about $1{\cdot}6 \times 10^{-6}$ cal. per square centimetre per second. Thus a layer of average granite 16 kilometres thick would account for all the heat leaking out of the earth. This remarkable result was obtained by the present Lord Rayleigh. That it demanded careful reinvestigation of the theory of the cooling of the earth was obvious; and some writers went so far as to deny that the earth is cooling at all. The situation, however, was never so serious as this. Either the total radioactivity is less than that of 16 km. of granite, or it is greater. If it is less, the earth is cooling to some extent, though less than the simple Kelvin theory indicates; if it is greater, it is impossible to explain why the amount of heat being conducted out of the earth is as small as it is, for the heat generated must be going somewhere.

A way out of the impasse was found by Dr. Arthur Holmes, in a series of papers in the *Geological Magazine* for 1915 and 1916, which have not yet attracted from physical writers the attention they deserve. Taking the extreme case of no cooling, so that the temperature within the earth is now everywhere steady, he worked out the depths of rock of various types needed to give the observed surface temperature gradient, and hence the temperatures at various depths. He found that if the radioactive layer was average granitic rock, the temperature within the crust could nowhere exceed that at the surface by more than 300°. Such a temperature is quite inadequate to explain the occurrence of volcanoes and igneous intrusions within the continents, and points definitely to another source of heat, which it is natural to refer to the primitive store.

Holmes therefore assumed a cooling earth, with radioactivity falling off exponentially with the depth; the mathematical solution of this problem had been given by Ingersoll and Zobel, but not applied to the actual conditions of the earth. If the rate of generation of heat per unit volume is Ae^{-ax}, it was found that

$$\left(\frac{\partial V}{\partial x}\right)_0 = m + \frac{S}{h\sqrt{(\pi t)}} + \frac{A}{ak}\left(1 - \frac{1}{ah\sqrt{(\pi t)}}\right).$$

This equation contains now two unknowns, t and a. Thus it can no longer be used for finding t; but that does not matter, because radioactivity gives us an independent determination of t. The disintegration of uranium produces lead at a known rate, and hence the analysis of a uraniferous rock makes it possible to estimate the time elapsed since that rock crystallised.

By this method the age of the oldest rocks known has been determined as 1400 million years, and it is probable that the whole age of the earth is about 1600 million years. With this extra datum we can find a. It turns out that radioactivity at a depth of 13 km must be $1/e$ (that is, 0·37) of what it is at the surface, that at 26 km. $1/e^2$, and so on. On this basis it is found that the differences between the present temperatures at various depths and the melting points of peridotite at the same depths are as follows:

Depth (km)	0	37	74	111	148	185	222	259	296	333	370	444	518	592
Temperature differences (degrees C.)	1400	940?	830	710	600	510	420	340	280	210	170	95	50	25

Below 600 km. or so the cooling is inappreciable. The cooling at depths of 200 to 300 km. is not so great as to forbid occasional softening of the more fusible constituents of the Femi, so that the existence of vulcanism is consistent with these estimates.

I have performed the corresponding calculations for another hypothesis differing as far as possible from that of Holmes; namely, I supposed the radioactivity uniform down to a finite depth and zero below that depth. The effect of the change is not great: the cooling at all depths is increased by about 16 per cent.

The above calculations are based on numerical data differing somewhat from those used by Holmes, and also from those used by myself in previous work. Previously I used as the primitive surface temperature the melting point of basalt, 1200°, seeing that it was the deep-seated rocks whose initial temperatures would have the greatest influence in determining present temperatures. But L H. Adams,[2] in a recent rediscussion of the whole matter, has pointed out that I did not go far enough, and adopts 1400° as his standard melting point; this datum has been used above. At the same time he has made an allowance for the difference between the conductivities of rocks at different depths. The effect is to increase the amount of radioactive material and reduce the cooling, but the general trend of the results is not violently changed.

[2] Jour. Wash Acad Sci, 1924.

The Royal Academy Exhibition.

IN a little book on "The Revolutions of Civilisation," with abundant illustrations of the arts of many ages, Sir Flinders Petrie has sketched out a sequence of rise and decline of civilisations in eight periods from the dawn of history, six of them between 6000 B C. and A D. 2000 It is through the arts that the sequence is manifest the several arts keep an order of precedence, they reach in turn a maximum of development; and in turn decay In each period sculpture is the first of the arts to reach its maximum phase, followed by pictorial arts and then in turn by literature, mechanics, and finally by wealth So also, in each period, the first signs of decay are manifest in sculpture; the decay of pictorial arts comes next. Medieval civilisation developed its maximum phase of sculpture in the thirteenth century, of painting at the end of the fourteenth, of literature at the end of the fifteenth; we are now in the maximum phase of mechanics, and all we have in prospect before our period goes out and the ninth becomes dominant is a maximum of wealth.

Suppose a visitor properly imbued with these ideas of revolutionary civilisation should find himself among the Royal Academy pictures of 1925, with room to see, and leisure to think about, the fourteen hundred items of the exhibition, what impression would he get? What would he think of sculpture which already showed signs of decadence four centuries ago? It is represented by reliefs, as 1273, *The Late Bishop of Hereford* for his Cathedral, by Allan Wyon, recumbent statues of *Lord Kitchener* in marble (1381) for St. Paul's, W. Reid Dick, and *The Late Bishop of Coventry* in bronze for his Cathedral (1377), by Sir Hamo Thornycroft, R.A., many figures, busts and statuettes, and some really convoluted animals, *Wild Swans* (1222), *Eagle, Lynx, and Hare* (1223), by the Danish sculptor Holger Wederkinch. Is a recumbent statue the imitation of a bygone habit of centuries ago or a step in the progress of the realisation of an art which also strives to represent action, as in a bronze *Atalanta* (1414) by Sir Bertram Mackennal? After he had assigned the position of sculpture, between the failing light of the eighth period and the dawning of the ninth (making what allowance is necessary for "copying," with which Sir Flinders Petrie declines to concern himself), what would he think when confronted with 477, *Sir Donald MacAlister of Tarbet*, as portrayed by Maurice Greiffenhagen, R.A., or 79, *A Street Accident*, by Glyn W. Philpot, R.A., or 340, *The Soul's Journey*, according to Mrs. A. L. Swynnerton, A.? How would he relate them to the golden age before the cinquecento? What, anyway, could the student of civilisation have said if 160, *Man Versus Beast (Paris)*, Sir William Orpen, R.A., happened to have been unearthed from an Egyptian tomb instead of being exhibited as a novelty in a London gallery?

It is a well-arranged exhibition: the oil paintings, which number only 631, are hung within comfortable view, mostly in not more than double rows. These are supplemented by 407 water colours, miniatures, drawings, engravings or etchings in the South Rooms, 174 architectural drawings and 207 sculptures.

One gets the impression of alternations of portrait and landscape with very few historical or subject pictures, more uniformity of excellence and fewer striking exceptions than usual. There are, once more, a number of examples of brilliance of illumination by La Thangue obtained by juxtaposition of light and shade: 42, *Amalfi Vines*; 84, *A Provençal Flock*; 141, *The Thorn*; and 175, *The Trout*. There are some efforts of a similar character not nearly so successful: 305, *Jack, Jill, and Peter*, Dorothea Sharp; 407, *A March Morning*, Harry Fidler; and better than these 537, *Eucalyptus Avenue*, Mary H. Carlisle. There are also striking examples of moonlight brilliance by the juxtaposition of iridescent colours; 14, *Silver Moonlight*, and 129, *The Ebbing Tide*, Julius Olsson, R.A.

For the spectator, whose days belong to science and to whom the technique of art is a mystery, the landscapes naturally afford more food for reflection than the portraits; and the comparative uniformity easily leads to thinking about the colour schemes of Nature, as expressed by different artists. There is a whole gamut of variation between the blue middle distance and

red background of 150, *Evening Glow on Rosengarten*, by Adrian Stokes, R.A., and the colourless grey whiteness of sheep in 252, *A Blizzard*, by Joseph Farquharson, R.A.

All Adrian Stokes's pictures are indeed notable for their colour scheme; 7 and 18 present beautiful contrasts of yellow and crimson foliage with the blue vistas of distance in Italy, whereas in 229, *Green Haunts*, an English forest, green is everywhere, only relieved by patches of sunlight on a somewhat ruddy path One can indeed classify the landscapes by their blueness, their redness, or their whiteness, and can speculate as to how far any differences are due to idiosyncrasies of colour vision or to a true appreciation of the fact that clouds of the very smallest kind of particle in the atmosphere are blue to look at, but red to look through; while clouds of larger particles are white to look at and grey to look through. So, in Italy, as already noticed, or in Spain, 570, *Among the Mountains*, Christopher Williams, where particles are very small, made perhaps of the finest dust or of wood smoke, distance is blue and setting suns are red, whereas in the Western Highlands, where particles which are not considerable water drops are scarcely to be found at all, distance is colourless and sunsets are practically white Even in Spain, 117, *Bridge at Toledo*, Oliver Hall, A., the grey is scarcely to be called blue.

The Exhibition offers many suggestive examples of these various points of view. As white or grey pictures, 8, *Morning Light*, Clewin Harcourt; 12, *Waterloo Bridge, November Dawn*, Algernon Newton, 39, *Blythburgh from Henham*, B. Priestman, R.A; 51, *On the Eastern Rother*, P. H. Padwick; 52, *The Bathers' Pool*, Algernon Talmage, A.; 111, *The Woodland Way*, W. W. Ouless, R.A.; 169, *Evening, Trepied, Pas de Calais*, Sir H. Hughes-Stanton, R.A.; 187, *Kilchurn Castle, Loch Awe*, Sir D. Murray, R.A.; 240, *King George V. Dock*, W L Wyllie, R A.

There is blue but grey blue, very true in tone, in 69, *The Farm on the Hill*, Arnesby Brown, R.A.; 275, *Himalayan Snowfield*, C. W. Bion, has grey blue; 472, *A Bule Hill Far Away*, Sir D. Murray, R.A., a very grey blue. There are blue distances in 292, *Blossom Time*, F. F. Foottet; 293, *Hoar Frost*, W. H. Adams; 631, *The Valley of Clitunno*, Freda Marston. So blue becomes more pronounced until 553, *The Blue Lake*, Sydney Lee, A., is almost incredibly blue. 110, *The Fountain of Neptune*, by the same artist, has the deepest of blue for a background; so has 130, *Miss Pearl Hood*, a portrait by Greiffenhagen. 596, *Almost Night, Venice*, Terrick Williams, A., is all blue; that must presumably be a question of colour vision. J. C. Moody, in 92, *Into the Sun's Reflections*, colours the nearest black post blue; that must also be similarly classed if the blue of blue smoke is what physicists suppose it to be.

Red is more rare: it is the most transient of atmospheric colours except the green of the departing sun; such examples of red as there are are not very convincing.

Painters are still inappreciative of certain proprieties about clouds; some types are appropriate to early morning and others to afternoon and evening. A lapse in this respect, 159, *A Summer Morning*, George Clausen, R.A., gives the impression of restlessness that one feels before a thunderstorm, always a restless phenomenon A similar feeling comes from the sky and lighting in 618, *The Bathers, Pas de Calais*, and other pictures. Something impels an artist to throw some sort of action into the sky, hence one finds thunderstorms "standing where they ought not" On the other hand, there is a beautiful English restfulness about 58, B Priestman's *Lock Pool*.

Of the portraits the stark apparition of Sir Donald MacAlister has already been hinted at; an easily recognisable portrait of *Lord Rayleigh*, 211, by Melton Fisher, R.A, is not far on one side from a less easily recognisable portrait of the Master of Sempill and his wife; or, on the other side, from one of *Lady Rayleigh*, 556, by W. W. Russell, A., not quite so reposeful. *Sir Humphry Rolleston*, 260, by George Henry, R.A., comes freshly before us as the new Regius professor at Cambridge. The president of the Institution of Civil Engineers is there, 186, by Stanhope Forbes, R.A, the Deputy Master of Trinity House, 245, by R. G. Eves, and a number of portraits of doctors of various academic faculties. That brings us back to wondering where in the sequence of the revolution of civilisation clothes ought to be put. Are fine clothes or no clothes a sign of civilisation or are they not? And if they are, have we reached the zenith? Are we approaching it or have we passed beyond it to a period of decay? Neither sculpture nor painting in the Academy will give a conclusive answer in the year 1925, though both may give cause for thought about it. Without doubt, if they are not mere echoes of a loftier age and are, indeed, real flowers of the artistic genius of the twentieth century, 139, by Sir William Orpen, R A., and 102, by Sir Arthur Cope, R A, and not a few others, will suggest to anthropologists that the sartorial art of the eighth period must be at least very near its climax, for even Solomon in all his glory was not arrayed like some of these.

The University Celebrations at Pavia.

(FROM A CORRESPONDENT.)

WHEN is a university not a university? That is the riddle set to the philosophic historian by the spirited claim of Pavia to be the oldest university of Europe. The answer mostly given is *not* before the twelfth century, if it was then when the name *Universitas, i.e.* of students from different nations and of different subjects, began to displace the older term of *Studium Generale*, which lingered on in Italy for many centuries. But the distinguished writers on medieval law and history who have made Pavia well known in recent years, especially the present Rector, Prof. Arrigo Solmi, seem to be justified in maintaining that when a summons is issued by a great monarch, the greatest of his day, to a number of towns in a wide area, to centralise their efforts in all studies beyond school-level in a single spot under the direction of one eminent teacher and his colleagues, whom the said monarch has expressly invited and established, it becomes a question of name rather than fact whether we call the result a university or no.

History, in fact, has repeated itself many times in such matters. When Napoleon had freed Piedmont from the Austrians, he invited to Pavia in 1805, at the advice of a scholarly nobleman of Milan, a number of eminent professors, of whom Alessandro Volta, a founder of electrical science, was the greatest; but in doing so he only did for Pavia in his day what the Emperor Lothair, whose throne and title Napoleon claimed, had done by his famous proclamation, or *Capitulare* as he called it, in the year 825; for in that year Lothair established the well-known Irish monk Dungall in Pavia and bade all the chief cities of the western half of North Italy, including Genoa, Turin, and Milan, to send their students and teachers to Pavia. The curious may read of Dungall and his far-seeing letter in answer to Charlemagne's question about certain eclipses of the sun, in the "Dictionary of National Biography"; and that Pavia has worthily maintained the tradition of liberal and progressive study which he there set up, cannot be questioned

The debt which Pavia owed to Ireland, she repaid to England in the person of the great divine and lawyer Lanfranc, who, beginning as a student and teacher of Pavia, became head of an abbacy in Normandy and was chosen by the Conqueror as his chief adviser in England, and made the first Archbishop of Canterbury under Norman rule. His work there reflected, we learn, the conspicuous service which Pavia itself rendered to European progress, in combining and harmonising the established principles of Roman and Canon Law with the comparatively barbarous but deeply rooted customs of northern Europe, a fusion of which the Feudal system had been itself a product The central ceremony of this "eleventh centenary" of the University of Pavia was the unveiling by the King of Italy of a monument to the memory of Lanfranc in one of the courts of the University. This is a seated bronze figure of a robust and shrewd-looking but also beautiful damsel holding a scroll labelled LEX, personifying Lanfranc's contribution to the civilisation of Europe.

This spirit of conciliation and harmony between friends, neutrals, and even former enemies, from without and from within, was conspicuous in the recent festival. Germany, Hungary, and Turkey, no less than Switzerland, Spain, Holland, and Scandinavia, sent representatives to join those from the allied countries, Czecho-Slovakia, Poland, France, Belgium, Esthonia, the United States, and a particularly numerous contingent from the British Empire (among them Sir Martin Conway, Prof. Edmund Gardner, Prof. Alfred Parr, and Prof. Moffat of Madras). But from the Italian point of view the harmony of different sections of Italian feeling was new and most remarkable. A new university banner presented by ladies of the town was blessed by an archbishop and a cardinal who conducted a special Mass; a proceeding which could scarcely have happened in any Italian university since Napoleon's time. This same cardinal is a rugged and noteworthy personality, Archbishop Maffi of Pisa, whose general support of the present government has been varied by his courageous and dignified protests against ill deeds like the murder of Signor Matteotti, for which it is generally assumed that some section of the Fascisti was responsible. Yet he appears on the same platform with the Minister of Education who bore Mussolini's express good wishes, and expressed a lively interest in the record of the University, the work of jurists like Buonfiglio and Bagelard, Latinists like Laurenzo Valla, and men of science from Volta to the venerable physiologist, the Nobel prizeman, Prof. Golgi, who was present at the ceremony

The admirable address of the Rector was a model of precision and enthusiasm, tracing in the work of Pavia the combination of "Scienza" and "l'Idealità," scientific method and humane ideals. Only one detail must be here added, significant of the many-sided activity of the University. Practically all the wine of the district, wine of many qualities and colours, but all (by common consent of the visitors) excellent in their kind, is produced by a co-operative union of some 3000 cultivators; and the chairman of the union is the professor of botany. He was also until recently an anti-Fascist member of the Italian parliament; and some of his supporters expressed to the present writer a pleased surprise that he was allowed to continue unmolested both his professorial and his agricultural work. It may be foretold with some confidence that the immediate future of Italy has many such pleasant surprises in store; for the spirit of the now renascent Italy is precisely that which has governed and inspired the celebrations at Pavia.

Obituary.

Sir William Fletcher Barrett, F.R.S

THE death of Sir William Barrett, F.R.S., on May 26, at eighty-one years of age, removes one who dates back to a period in physics long antecedent to all the recent advances—the period of Wheatstone and Balfour Stewart and Tyndall. He never pretended to follow the recondite mathematical and dynamical investigations of last century, typified by the great names of Stokes and Thomson and Tait. The original discoveries in physics which he himself made concerned such things as—sensitive flames, which he first observed while working in the 'sixties on sound in Tyndall's laboratory at the Royal Institution; some alloys of iron, especially a useful one called stalloy, which he claimed to have announced in 1899; and the odd behaviour of iron at or near the magnetic critical point. In this last phenomenon, a hot iron wire under longitudinal strain not only suddenly expands but also rises in temperature, giving a momentary glow which he called calorescence, since he regarded it as an example of a rise in the refrangibility of emitted radiation—presumably by molecular or atomic rearrangement—in contrast to the lowering of refrangibility (or what we now call frequency) so well elaborated by Sir G. G. Stokes under the name fluorescence.

As a popular lecturer and teacher in the experimental phenomena of physics Barrett was very successful, and he must have often contributed welcome information at meetings of the Royal Dublin Society.

His first and only academic chair was at the Royal College of Science in St. Stephen's Square, Dublin, which he assumed in 1873 and vacated in 1910, during

which period it may be safely said that the College which he faithfully and effectively served underwent several threatenings, if not vicissitudes, thereby causing him anxiety which he did not hesitate to express.

The main interest of Barrett's middle and later life lay in the exploration of obscure human faculties, such as were not receiving attention from the majority of scientific men and were often cold-shouldered as mere surviving superstitions. He felt that in this unlikely milieu there lay hidden a grain of truth, which he set himself pertinaciously to find and enthusiastically to exhibit to others. He was in frequent touch with such other explorers in unpopular regions as Alfred Russel Wallace and William Crookes, and he never doubted that between them they had unearthed some genuine phenomena, which, though sometimes bizarre and apparently incredible, would ultimately be accepted by science, and might, he hoped, prove of moment to mankind. It was in this faith that he worked, and stimulated work in others. How far he was justified, posterity will know better than we. It must be made quite clear that many men of science deny all these asserted phenomena, and apparently do not consider them worthy of serious examination. That care and caution is necessary in such a region is well known, but even now there are several who have little or no doubt that a faculty of communion or communication between individuals exists which is independent of the recognised organs of sense; and of this faculty Barrett considered that he might hereafter be regarded as perhaps the chief discoverer. So far as I know he had no theory on the subject; he was content with observing and recording the facts, observed under what he considered adequate precautions against deception. He read a paper to the British Association at Glasgow in 1876 on what was later called telepathy, but the feeling of improbability about the reality of such a faculty was so strong that its publication was suppressed. He did, however, get a letter published in NATURE for July 1881, shortly before the foundation of the Society for Psychical Research

Another inquiry, which he carried out in Dublin, related to the asserted Reichenbach phenomena, *e g* the sensitiveness of certain people to magnets These experiments, though carefully conducted, led to no conclusive result, when all opportunity for suggestion and all normal clues were eliminated.

On yet another faculty he became quite an authority, namely, the faculty for finding water or other things by means of an unconscious physiological reaction, demonstrated usually by the twisting of a rod held in the hand. The possession of such a faculty can be pretended or imagined, but Barrett came to the definite conclusion that in certain persons it was real, and could be utilised.

Finally, Barrett enlisted the interest of many distinguished scholars, both in the British Isles and in the United States, in the search for unrecognised but traditional human faculties; and he had a stimulating hand in founding the Society for Psychical Research in London, with a branch in Dublin; and also a somewhat similar society in America, the latter being at one time presided over, no doubt in a reasonably incredulous spirit, by no less a person than Simon Newcomb; who probably held the opinion that everything might legitimately be explored, and if necessary condemned, in the interests of truth.

On the personal side it must be admitted that some people found Barrett's quick eager manner unrestful, but every one recognised the transparent honesty and simplicity of his character, and could not help admiring the keenness with which, right up to the end, he was ready to undertake any labour to get phenomena properly observed and recorded. Correspondents from all over the world must have sent him tales of extraordinary happenings, and a winnowed selection of these he contributed from time to time to the Proceedings of his special Society. With its slow and cautious methods he was often impatient, urging greater enterprise and activity, but he accepted its presidency for a year, and continued on its Council to the end.

Barrett's domestic life was of the simplest. Through most of the years his sister kept house for him, until 1916, when, to his extreme happiness and content, he married the distinguished surgeon and gynæcologist Mrs. Florence Willey, M D. It was at her house that he died, through heart failure, in full possession of his faculties except his sense of hearing. He loved life, but, as his books show, he regarded the continuance of existence, in some still personal form, as almost if not finally demonstrated. Death did not seem to him an interrupter of mental continuity.

So has passed over one who served truth to the utmost of his ability, whose researches brought him into personal contact with all sorts and conditions of men, one who was not deterred by ridicule or opprobrium from following such clues as he could find, yes, and if his chief interest is ever universally recognised as well founded, one who will be hailed and respected by posterity as a pioneer. OLIVER LODGE.

FATHER A. L. CORTIE, S.J

FATHER ALOYSIUS LAURENCE CORTIE, S J, who died on May 16, was born in London on April 22, 1859. He had thus attained the age of sixty-six years. His cheery genial ways left the impression of his being a much younger man, and he will be mourned by a wide circle of friends who enjoyed his companionship in his merry moods and valued it in his more serious moments. He was educated at Stonyhurst, and having joined the Society of Jesus at Roehampton in 1878, he was ordained priest in 1892. For thirty years, with but little intermission, he was on the staff of Stonyhurst College teaching physics and mathematics, and he was also director of music for nineteen years. He was a very popular teacher, and the hold which he gained on the affection of the boys was maintained throughout his life, for he continued by correspondence in touch with his old pupils in all parts of the world. No Stonyhurst gathering was considered complete without Father Cortie. His songs and his quaint stories were equally welcome. His quick sense of humour enabled him to pick out many a local episode, which he would recount in the Lancashire dialect to the great amusement of his hearers. He was in great demand as a popular lecturer on astronomical subjects, and as his humorous touches seemed to give almost as much amusement to himself as to his audience, his call on their interest and sympathy was irresistible and met with immediate response.

Father Cortie took a large share in the work of the Stonyhurst College Observatory during the directorship of Father Sidgreaves (1890–1919), and he became director in 1919 on the death of Father Sidgreaves. His astronomical work was in large measure connected with the relation between the phenomena of sunspots and terrestrial magnetism, and he contributed many papers to the Royal Astronomical Society and to the *Astrophysical Journal*, among them were a number relating to stellar spectra, a subject to which Father Sidgreaves had devoted much attention.

Father Cortie, carrying on a tradition started by Father Perry, took part in several expeditions to study the phenomena presented in total eclipses of the sun He travelled to Vinaroz (Spain) in 1905, to Vavau, Tonga Islands, in 1911, and to Hernösand (Sweden) in 1914, to make observations of eclipses. He had but poor luck in the earlier expeditions, but in Sweden he observed the eclipse "in absolutely perfect weather conditions" and obtained not only valuable spectroscopic observations but also beautiful photographs of the corona, one of which is well reproduced in the Report of the Stonyhurst College Observatory for 1914.

In 1891 Father Cortie was elected a fellow of the Royal Astronomical Society, and for many years he served on the council of the Society. He was an active member of the British Astronomical Association, which he joined in 1894, for eleven years (1900–1910) he was director of the Solar Section of the Association, and in that capacity he was responsible for many reports on solar work. He was president of the Manchester Astronomical Society since 1911. In 1922 he was made a member of the International Astronomical Union's Committee on the Solar Atmosphere and attended the meeting of the Union at Rome in that year After the meeting he received an honorary degree at Padua on the occasion of the seventh centenary of the foundation of the University. Quite recently he had been elected president of the Manchester Literary and Philosophical Society.

We regret to announce the following deaths:

Dr. A G Butler, late senior assistant keeper of the Natural History Museum and distinguished as an entomologist and ornithologist, on May 28, aged eighty years.

Dr John Mason Clarke, State geologist and palæontologist and director of the State Museum and Science Division of the Education Department, New York, a fellow of the National Academy of Sciences, Washington, and foreign member of the Geological Society of London, sixty-eight years of age.

Prof. Giovanni Battista Grassi, Senatore del Regno, distinguished for his work on the transmission of malaria, on May 4, aged seventy-one years.

Prof. C K Wead, an examiner in the United States Patent Office and formerly professor of physics in the University of Michigan, who was known for his work on physical and musical acoustics, aged seventy-six years.

Current Topics and Events.

The Rowett Research Institute, Aberdeen, for the investigation of problems of animal nutrition, has been fortunate in receiving funds from private sources Two years ago Mr W. A Reid, of Aberdeen, endowed the Library and Statistical Department. The Institute has now received a gift of 10,000*l* from Mr Duthie Webster to support the work of an experimental stock farm. Mr Webster, who is an Aberdeenshire farmer, is the nephew of the late Mr William Duthie, of Collynie, who earned world-wide fame as a breeder of beef cattle. The farm is being established in accordance with recommendations made by Prof. T. B Wood, Director of the Animal Nutrition Institute at Cambridge, and Dr J B. Orr, Director of the Rowett Research Institute, in a joint report which, at the request of the Agricultural Council, was drawn up and submitted to the Ministry of Agriculture and the Board of Agriculture for Scotland. One of the sections of that report emphasised the desirability of having in Great Britain one or more experimental stock farms where the results of research work, which appeared of probable economic value, could be tested on a large scale, under practical conditions. In the report it was recommended that such a farm should be established in connexion with the Rowett Research Institute

The scheme, which is now being carried out at the Rowett Research Institute, makes provision for departments dealing with milk cows, beef cattle, pigs, sheep and poultry, and it is intended that each department will have as its head a worker who, after having been trained in research in nutrition, will devote himself entirely to the study of practical problems connected with the nutrition of the kind of farm animals in his department The establishment of this experimental stock farm in connexion with the Rowett Research Institute is an important development in the scheme of research in agriculture, promoted by the Development Commission some years ago It will enable the results of work, the full significance of which can only be understood in scientific circles, to be presented in a form intelligible to those engaged in the industry of animal husbandry. The results of large scale-feeding experiments carried out under practical conditions, should be of interest not only to stock breeders but also to those engaged in research, whose experimental work has to be confined of necessity to tests with small laboratory animals.

The recent Conference on the Standardisation of Plate Testing Methods, inaugurated by the Royal Photographic Society, appointed an influential committee to consider its work in detail and to draw up a report for submission to the coming Paris International Congress on Photography The report of the Committee is published in full in the Society's Journal for June The Committee recommends a standard illumination of 4-metre candles obtained by the use of a 15-20 c p. standardised metal filament lamp used at a colour temperature of 2360° K., this having the same colour as the Eastman Kodak acetylene flame. For exposure it recommends a non-intermittent exposure mechanism and a time scale, intensity remaining constant. When uniformity in the developer is desirable, it recommends the pyro-soda formula of Hurter and

Driffield, but of three-quarters the strength prescribed by them. The Committee recommends development in a dish, and the use of a brush to produce an efficient turbulence over the whole surface of the plate For measuring the densities it advises the use of a definite instrument and a definite opal glass in contact with the density being measured The pieces of opal glass should be standardised at some such institution as the National Physical Laboratory. For the interpretation and statement of results a set of curves plotted in the usual way for at least three periods of development is recommended. The effect of fog needs further investigation. The under-exposure portion of the curve should be given separately, and an illumination of $\frac{1}{100}$ m c is advised for work in this region, and it may be obtained from the standard light source by reflection from a magnesium oxide screen It is hoped that these conclusions may form a basis for the standardisation of plate-testing methods as discussed at the Paris Congress

PROF F A. F C WENT, professor of general botany in the University of Utrecht, lectured on "Modern Conceptions of Light Stimuli in Plants" at the Imperial College of Science and Technology, South Kensington, on May 25 In the course of his address, Prof. Went stated that investigations which have been carried out during the last twenty years in Holland and elsewhere had cleared away many of the old conceptions concerning phototropic curvatures of plants. The work of Blaauw, Arisz, and Koningsberger were worthy of mention in this regard It was discovered by Blaauw that a certain quantity of light—expressed in metre-candle-seconds—is necessary to obtain a curvature in oat seedlings or the sporangiophores of Phycomyces Arisz made exact measurements of light-quantities and brought evidence against the view commonly held that perception and reaction are distinct processes. Moreover, he showed that when a plant is illuminated from two different sources, the curvature resulting is determined by the addition or subtraction of the two separate reactions. From this it seems probable that the so-called "tonus" is a question of the summation of reactions, not of perception. Blaauw's well-known explanation of growth curvatures as due to the light-growth-reaction has been confirmed by Koningsberger by means of a very accurate recording auxanometer. In future it will be necessary to work with light of which the energy value is much more accurately measured than in metre-candle-seconds. It is probable that in phototropic responses some substance of the nature of a hormone, such as has been demonstrated in relation to geotropic curvature, will later be detected. It is doubtful whether the use of the word "stimulus" is now of much value in phototropism.

A NEW development at the Royal Botanic Gardens, Kew, is a house for the display of plants of botanical and educational interest. The special display at present consists of Calceolarias. *C. cana* is a small hoary-leaved species from Chile with violet-scented flowers, and the hybrids which have resulted from it show the hoary leaves of *C. cana*, while the flowers show a wide range of colours from white through yellow to a deep purple red. The South American Calceolarias have the characteristic pouched flowers, but there are four exceptional species, with open helmet-shaped flowers, two of which occur in South America, *C violacea* and *C. punctata*, and two in New Zealand, *C Sinclairii* and *C repens* An exhibit of Petunias has also been arranged showing the development of the garden Petunia from the two wild species from the Argentine and Uruguay, namely *P. integrifolia* (syn *P violacea*) and *P nyctaginiflora* *P. integrifolia* is better known as *P violacea*, and was received as such by the Glasgow Botanic Gardens during 1831, seed being sent by John Tweedie, then resident at Buenos Aires, and a hybrid with *P nyctaginiflora* was raised during 1834 It was lost to cultivation for many years until 1916, when Kew reintroduced it, after several failures, through the kind offices of the late Mr. C E R Rowland, then Vice-Consul at Monte Video. An interesting new South African Composite, *Venidium Wyleyi*, is also exhibited, which has been raised at Kew from seed received from Miss Wilman of Kimberley, a well-known South African botanist The exhibits will be changed from time to time throughout the year

SHOWERS of fish have from time to time been reported, and the following account of one that occurred in the Hardoi district of Oudh, as given in a letter from the Deputy Commissioner of that district, has been forwarded to us by Mr C. A Silberrad: "The local calamity was of a new type. It happened in an area 200 yards wide and three miles long in the northern part of this district One evening in April 1924 a whirlwind rose in a small area It advanced to the east, and as it advanced it increased in velocity and force All the trees—big huge trees—were uprooted and carried long distances, not dragging on the ground but flying overhead. Fish in a 'tank' [*i e* reservoir or large pond] which came in the way were blown out and two villages were destroyed. About 45 men were killed or injured, and 150 cattle destroyed." A similar occurrence is recorded in the April-June issue of the *Australian Museum Magazine*, where it is stated that the Director of the Australian Museum, Sydney, recently received a bottle containing three small fish, which, according to the accompanying letter from Mr. F. Richards, of Gulargambone, New South Wales, "were found in the gutters and on the streets here, with hundreds of others after recent heavy rain" Examination of the fish showed they were small freshwater gudgeons (*Carassiops klunzingeri*), which are very common in streams and water-holes in western New South Wales and Southern Queensland

AN interesting illustrated account by T. W Jones of the life and work of Dr. Thomas Beddoes appears in April issue of *Science Progress*. Beddoes' greatest discovery was Humphry Davy, who was the first medical superintendent of his "Medical Pneumatic Institution" at Clifton. Beddoes was born at Shifnal in Shropshire in 1760, and at the time of

graduation in classics at the age of nineteen, he had acquired considerable manipulative skill in pneumatic chemistry and was conversant with the work of Priestley, Cavendish, Lavoisier, and Scheele. He studied medicine and anatomy in London and, later, in Edinburgh. After a continental tour, in which he met Guyton de Morveau and Lavoisier, he accepted the post of reader in chemistry at Oxford. Beddoes became very popular here and spent the happiest years of his life; rash political views, however, caused him to resign in 1792. He had published translations of Bergman's "Elective Attractions" and Scheele's "Chemical Essays," amongst many other things, and also a digest of the work of Mayow Beddoes now set up a practice, still continuing, however, his private research His published work of this period is voluminous; most of it is medical in nature, but there is a 'classification of chemical substances according to their principles," which he proposed. Much of Davy's earlier work was inspired by Beddoes, and was carried out under the latter's direction, *e g* the work on nitrous oxide which brought about Davy's promotion to the Royal Institution

METEOROLOGICAL reports by wireless telegraphy for Great Britain and the countries of Europe and North Africa are dealt with by the Meteorological Office, Air Ministry, in a new edition of official publication, M O. 252. The third edition of the work now issued consists of 134 pages, which, compared with 84 pages in the first edition issued in 1922, illustrates the immense development of wireless now in progress A frontispiece shows the area covered by wireless weather messages employed in the Daily Weather Service of the British Isles, from which messages are regularly received by the Meteorological Office of the Air Ministry The area embraces nearly the whole of the northern hemisphere. To obtain observations from the entire network of observing stations, most or all of the national issues must be intercepted, but the whole area may be approximately covered by utilising only the international collective messages issued by Great Britain, France, Germany, and Russia. Most issues can be received in the British Isles by the use of quite modest receiving apparatus. Details of the meteorological messages transmitted by each country are given on a uniform plan. The reports and times of the messages are made perfectly clear. The international codes are given of reports from land stations, reports from ships at sea, abbreviated reports giving a synopsis of the meteorological situation over the continent, with much detailed information of general application for weather study. Details of the particulars of the messages from different countries are given up-to-date according to information available on February 14 of the current year, and emending notices will be issued as alterations are required. Such notices will be issued free until a new edition is ready, on application to the Director of the Meteorological Office. The work is published by H.M. Stationery Office, price 3*s*. 6*d*. net.

IN order to study the possibilities of routes through central Africa, particularly between French Equatorial Africa and the East coast, Citroën Cars Limited has sent a large motor expedition across the continent. From Algeria the expedition crossed the Sahara to the Niger river, and then by Lake Chad to Banghi on the Ubanghi, a tributary of the Congo, which form the southern frontier of French Equatorial Africa. After a deviation to the little-known north-eastern part of the Ubanghi-Shari territory, a return was made south to Stanleyville on the Congo. From there the route was north-east through the Haut-Uele district, and eventually to Kasenyi on Lake Albert, which was crossed to Butiabwa. The route then lay south-east to Entebbe, across Lake Victoria and to Tabora. At Kampala one party branched off for Mombasa, and at Tabora another party turned west to cross Lake Tanganyika, and ascended the Lualaba valley through the Khatanga region and Rhodesia to Cape Town. The main expedition from Tabora was to proceed by Lake Nyassa and Blantyre to Beira All the parties were to reunite at Mayunga on the west coast of Madagascar and cross the island by Antananarivo to Tamatave. Thus the whole of French Africa will have been traversed by motor car.

AT the annual general meeting of the Institute of Physics, held on May 25, Sir William Bragg was elected president in succession to Sir Charles Parsons, whose term of office expires on September 30 Major C E. S Phillips was elected to succeed Sir Robert Hadfield as treasurer The annual report gives the total membership as 515, which includes 293 fellows and 135 associates There is stated to be unlimited scope for further applications of physics in the arts, industries, and public services, and therefore for the increased employment of highly-qualified physicists, and during the past year there has been a fair demand for young honours graduates in physics with two or three years' research experience. Seven lectures have so far been given in the series on "Physics in Industry," and they have been published in three volumes by the Oxford University Press. Much of the report is devoted to the *Journal of Scientific Instruments*, the second volume of which is now appearing. Editorial control has been brought into closer touch with the scientific instrument industry, and steps have been taken to procure more descriptions of workshop devices and methods. Action has been taken in conjunction with the Institute of Chemistry in urging upon the Board of Trade the desirability of defining, in the public interest, the qualifications that should be required of Gas Examiners appointed by local authorities under the provisions of the Gas Regulation Act, 1920. In this connexion a deputation from the two Institutes waited upon the Board of Trade. In reply to the deputation it was stated that the changes in the method of appointment of Gas Examiners suggested by the deputation indicated the necessity for further statutory powers.

THE Ladies' Conversazione of the Royal Society will be held in the Society's rooms on the evening of Wednesday, July 22.

THE summer meeting of the Newcomen Society for the Study of the History of Engineering and

Technology is to be held on June 17–20 at Gloucester. The meeting includes visits to works and places of antiquarian interest in the neighbourhood. Particulars can be obtained from the honorary secretary of the Society, Mr. H. W. Dickenson, Science Museum, South Kensington, London, S W 7

THE Science Museum at South Kensington, being too crowded on public holidays for the ordinary lectures to be given in the galleries, an experiment was made on Whit-Monday by Engineer-Capt E. C Smith, the official guide lecturer, giving short lectures on ships, locomotives, and aeroplanes in one of the new demonstration rooms. The lectures were illustrated by slides, models, and sketches, and drew large audiences The experiment may be regarded as entirely successful, and we hope these holiday lectures will become a permanent feature of the work of the Museum

WE learn from *Science* that the Barnard Medal for Meritorious Service to Science, awarded by the trustees of Columbia University on the nomination of the National Academy of Sciences, has been given to Dr. Niels Bohr, professor of physics at the University of Copenhagen, in recognition of his researches on the structure of atoms Previous recipients of the Barnard Medal are Lord Rayleigh and Sir William Ramsay (1895); Prof. W. K von Rontgen (1900); Prof Henri Becquerel (1905), Sir Ernest Rutherford (1910), Sir William Bragg and Prof W L. Bragg (1915), Prof. Albert Einstein (1920)

IT is a hundred years since John Phillips, afterwards professor of geology in King's College, London, in the University of Dublin, and in the University of Oxford, was appointed the first keeper of the Museum of the Yorkshire Philosophical Society. In the recently issued annual report of the council of that Society, Dr. W. E Collinge, the latest successor of Phillips, takes occasion to give an interesting account, illustrated by a good portrait, of the great geologist of Yorkshire. He suggests that a John Phillips Geological Department would form a fitting memorial The council, however, seems to be concentrating on an extension of the Museum to accommodate the Roman antiquities

AFTER the death of Dr Peringuey in February 1924, and pending the appointment of the new director, Mr. E. Leonard Gill, who assumed office on January 1 of this year, the work of the South African Museum was under the supervision of Mr. K. H. Barnard, who is responsible for last year's report. The much-needed whale shed was completed during the year, and the whale skeletons re-erected therein, proving a great attraction to the public Several short talks on matters connected with the Museum have been broadcast. The excellent custom of employing members of the staff on collecting expeditions and surveys was continued, though somewhat interfered with by the administrative changes. The chief acquisitions by this means were in plants, insects, and arachnids.

AN interesting paper on the early Bristol glasshouses appears in the March issue of the Journal of the Society of Glass Technology. It contains historical details of the fortunes of many glass-making firms, and is based mainly on contemporary newspaper accounts. The earliest record of glass-making in Bristol occurs about 1651, when Edward Dagney (or Dagnia), an Italian, had a glasshouse, of which the master was John Williams The trade rapidly grew; in 1698 there were six glasshouses for bottles and four for flint glass, in 1761 there were fifteen, and in 1792 "about twelve" (probably concerns or firms) The Bristol industry began to decline during the early part of the nineteenth century, owing to the remoteness of coalfields and Irish competition

THE most recent Catalogue (No. 68) of Messrs Watson and Sons (Electro-Medical), Ltd, consists of Part I, dealing with X-ray generators and radium, and Part II with X-ray accessories. In about three hundred pages a brief descriptive account is given of radiological apparatus covering the field of radio-diagnosis and radio-therapy We notice a description of the Gaiffe-Gallot and Pilon constant tension apparatus which Messrs Watson are authorised to manufacture in Great Britain One of the most attractive features of the catalogue is the conciseness of descriptive details concerning apparatus, combined with excellent illustrations.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned A veterinary lecturer at the Midland Agricultural and Dairy College, Sutton Bonington, Loughborough — The Principal An assistant lecturer in chemistry at King's College for Women (Household and Social Science Department), Campden Hill Road, W 8—The Secretary (June 12). A junior scientific assistant in connexion with Admiralty Research—The Secretary of the Admiralty (C E Branch), Whitehall, S W 1 (June 16) Some appointments in connexion with the physical and chemical survey of the national coal resources—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S W.1 (June 17) The professorship of zoology at King's College, London—The Academic Registrar, University of London, South Kensington, S W 7 (June 19). An assistant entomologist at the Imperial Forestry Institute, Oxford—The Secretary (June 20) A junior lecturer in biological chemistry in the department of physiology of Bedford College for Women—The Secretary (June 20). An assistant in the Herbarium, Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S W.1 (June 22) The professorship of electrotechnics in the University of the Witwatersrand—The Secretary, High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (June 25). A senior lecturer in chemistry and physics at the Gordon College and the Kitchener School of Medicine, Khartoum—Dr. A. F. Joseph, 51 Kings Avenue, Muswell Hill, N. (July 14). A biology demonstrator at the Royal Grammar School, Worcester—The Headmaster.

Research Items.

ARCHÆOLOGICAL EXPLORATION IN INDO-CHINA.—Dr. R. Verneau describes in *L'Anthropologie*, T. 35, Nos. 1-2, the results of excavations in the caves of Bac-Son, Tonkin, by Dr Mansuy and Mlle. Colani of the Geological Service. Some years ago Dr. Mansuy demonstrated by excavations at Pho-Binh-Gia that the neolithic culture characteristic of Indo-China—the only type known until then—was preceded by a more archaic culture Three skulls associated with this early phase were found to differ entirely from the modern population. Further investigations, covering a large number of caves, have revealed a stone culture, apparently general over the area of excavation, of which the implements are of early palæolithic type—Acheulean. No fossil remains are present, and the animal bones found in the archæological deposits are all those of existing species This, coupled with the absence of any of the stages intermediate between the implements of Acheulean type and the polished neolithic implements of the later culture, points to an antiquity of no great degree such as might be inferred from the form alone of the early implements. It is suggested that a primitive culture lingered on until overwhelmed by the incursion of races acquainted with the art of polishing stone Two skeletons were found, one skull was sufficiently well preserved to admit of measurement, but whereas the skulls from the earlier excavation mentioned above were of a pure Indonesian type, this one is Melanesian; while another skull recently found in the cave of Minh-Cam in Annam presents the characteristics of a Negrito.

EARLY ART IN THE EUPHRATES VALLEY.—The light thrown upon Sumerian Art and its affinities by the discoveries at Tel el Obeid is discussed by Dr Leon Legrain in the *Museum Journal* (Philadelphia), vol. 15, No. 3. A foundation tablet of Ur-Engur suggests the identification of El Obeid with the city of Kesh and a connexion with Elam, from which tamed bulls and cows probably were first brought to Sumer The details of the dairy scene in the copper relief from the oldest temple at El Obeid help to explain archaic pastoral scenes from Susa, Tello, and Nippur. A text of Gudea of Lagash dealing with the organisation of the household of the god Ningirsk, refers to a dairy. It also in its ritual details suggests the old mythology of Elam. But while the Elamite was a hunter the Sumerians were farmers The Elamites represented the gods as composite monsters; the Sumerians adopted the same forms, but in Sumer the god soon assumes the appearance of a king seated on his throne, the ancestor animal surviving as his servant and emblem. A number of known monuments may be compared with the art of Tel el Obeid These, taken together, seem to bridge over the gap between the pre-Sargonic and pre-Elamite periods Similar objects have been found by the French at Susa, Tape Mussian, and Bandar Bushir. The pre-Elamite period, represented by the painted wares and engraved seals, seems to be the oldest. The Tel el Obeid art is not so primitive but is to be set apart from, and before the pre-Sargonic period, constituting a new period of art.

THE BIOLOGY OF WHITE MUSTARD.—This subject in the hands of F. Boas and F. Merkenschlager has given results of great scientific interest and of considerable practical bearing. Their results are published in the *Biol. Centralblatt*, 45, pp. 40-53, 1925. That white mustard had some peculiarities had long been known; thus since 1913 the great difficulty of growing the plant in water culture has been on record, and there are also reports as to its failure to develop in soils previously sterilised by heat. In both these cases, growth could be improved by adding strongly adsorbing substances to the culture medium. Attacking the problem from this angle, these authors now supply very good experimental evidence that these peculiarities are due in the main to the ready penetrability of the plant's tissue by anions If, for example, roots of mustard seedlings are placed in a 0 5 per cent. solution of ferrous sulphate, within 15-20 minutes the roots are covered with yellow-brown flecks of the hydroxide of iron, other plant roots remaining clear white for hours in such a solution The root systems of old flowering plants do not show this peculiarity to such a marked extent, but leaf-stalks and hairs show this same ready penetrability to anions As *Sinapis arvensis*, charlock, has the same peculiarities as *S alba*, though perhaps to a less degree, this seems to be the phenomenon underlying the practice of destroying charlock by spraying or dusting.

MAIZE IN SOUTH AFRICA.—The increasing importance of the maize crop in South Africa has led to an inquiry into the economics of its production in connexion with the capital required in maize farming, the equipment and labour necessary, the yields and returns obtained, the relation of yield to cost and other points of importance to maize growers. Incidentally, weak points in the system of farming have been exposed, providing valuable information to the farmers. The report on the Cost of Production of Maize Investigation for 1921-22 (by E. Parish, Orange Free State) sets out the means employed in obtaining information and the method of calculation adopted Costs for native labour, ox labour, and overhead charges were estimated on a comprehensive basis including such incidentals as perquisites, veterinary attendance, and the cost of stalk grazing and husks consumed. The range of costs per bag, including transport, on the thirty-nine farms investigated in a poor season was from 4*s.* to 1*l.* 14*s.* 11*d.*, the greatest number of results lying between 7*s.* and 9*s.*, but in a normal season the costs would be lower The crop yields showed a similarly wide range, from 0 43 to 8 0 bags per acre (1 bag = 203 lb.), and comparison shows that the relation between yield and cost is very close. Compared with similar figures for several states in U.S.A. the cost of manual labour in South Africa is greater per acre of maize, but land is relatively cheaper and ox labour is less expensive than horse labour. The cost per bag of maize may be brought down by adequate methods of farming, and suggestions are made for obtaining increased yields.

EARTH MOVEMENTS IN CALIFORNIA.—A most comprehensive scheme of research is now being carried out in California with the object of investigating from every possible point of view the alarming disturbances to which the earth's crust is subject in that region. A valuable summary of progress is outlined by Dr. A. L. Day in *Science*, vol. 61, March 27. The U.S. Coast Survey and the Hydrographic Office have triangulated the land and contoured the adjoining ocean floor, and have thus provided a trustworthy system of co-ordinates upon which future displacements can be accurately plotted. The Geological Survey and the universities in California are studying

the geology in adequate detail. The California Institute of Technology, the Mount Wilson Laboratory, and the Geophysical Laboratory of Washington have devised apparatus and established stations for the more systematic recording and study of local earthquakes. It is not surprising that great faults are found along the Californian coast, for the Sierra Nevada rise to more than 14,000 feet on the east, while to the west the ocean floor drops sharply to a depth of 12,000 feet. High temperature gradients and hot springs, and unusually great anomalies of gravity, show further that the region is one of exceptional instability. The danger zones of structural weakness are being carefully mapped, and in future the known directions and magnitudes of the creeping and tilting movements that occur along them as the stresses accumulate will lead to definite predictions of the place or places where earthquakes are likely to occur. Unfortunately, there is no certainty that prediction of the time of rupture is yet a problem that can be usefully attacked.

ABYSMAL SUBMARINE VOLCANOES.—The soundings made by the *Challenger* expedition have been investigated by M. J. Thoulet, *C.R. Acad. d. Sci., Paris*, March 16. In the oceanic depths he has found that, in some cases, the curves of submarine density, instead of continuing regularly to the bottom, begin to show a sudden increase in density, the amount of material in solution becoming suddenly greater than before. This appears to be due to the existence of basins, without outlet horizontally, containing submarine volcanoes, which give out materials which dissolve in the water. This increase of density at the bottom of the ocean is not general. In regions in the North Atlantic known to be volcanic, the proportion of bottom densities greater than 1·0280 is 84 per cent.; in the South Pacific it is 37 per cent., in the South Atlantic, 24 per cent.; Indian Ocean, 13 per cent.; and North Pacific, 2 per cent. M. Thoulet has specially studied certain regions, partly from the point of view of submarine topography and microlithology, and partly with regard to the density of the water. He expresses the view that it may be possible in this way to locate the position of abysmal volcanoes, and perhaps to evaluate the degree of their activity.

SUBSTITUTES FOR PETROLEUM.—In his presidential address to the Mining and Geological Institute of India (published in the Transactions, vol. 19, 1924), Dr. E. H. Pascoe dealt with the development of the oil industry, and paid considerable attention to the question of vegetable and other products as substitutes for petroleum. Practical experiments have been made with palm oil in the Belgian Congo, where, under tropical conditions, it has been found possible to run a two-cycle semi-Diesel motor on this fuel, resulting in the development of 10 h.p. at 500 revolutions per minute. The calorific value of palm oil is, however, 20-25 per cent. less than that of crude petroleum, so that even if it could be used satisfactorily under temperate conditions, the greater consumption unit for unit would have to be balanced by low cost to make it an economic proposition. Castor oil has already been successfully used as a fuel for internal-combustion engines, though, as with pea-nut, soya-bean, and coconut oils, its value for human consumption is great, and any application as fuel would involve the oil industry in serious competition with the food-stuffs and drugs industries. Tetralin is a tetra-hydro-naphthalene manufactured from coal-tar in Germany; this substance was used satisfactorily during the War in that country, when supplies of petrol were short, but it suffers from the same disadvantages as benzol, namely, rapid carbonisation and difficulty in starting the engine on it from the cold. The prospect of an extended use of tetralin is doubtful. Alcohol is probably the most promising of all the liquid substitutes for oil, chiefly because of the variety of raw materials from which it can be manufactured, *e.g.* molasses (sugar waste), maize, potatoes, sawdust, sulphite liquors (from paper manufacture), artichokes, sorghum, various wild fruits and berries, peat, corn-stalks, garbage and other waste products. Dr. Pascoe concluded his address by urging attention to efficient carbonisation of coal, not only as helping to solve future fuel problems, but also owing to a growing demand for metallurgical coke. The problem of the conversion of cellulose into fermentable material by simple and economic chemical or bacteriological processes is likewise one worthy of thorough investigation, and in commending this and other researches having a similar end in view to Indians for the benefit of posterity as much as their own country, he voiced a plea deserving of world-wide notice and support.

THE INITIAL VELOCITIES OF α RAYS FROM POLONIUM.—The α rays emitted by the same radio-active body have been found to have very nearly the same velocity, Geiger, using radium C, finds this to be true to within 0·5 per cent. Mlle. I. Curie, using polonium, found that the ranges of its α rays differed a little more than was to be expected by the theory, and in a paper in the *C.R. Acad. d. Sci., Paris*, March 16, she describes measurements made by the magnetic deviation method, to find the amount of difference in the velocity of these rays on emission. The rays were passed through two parallel slits before being deviated, and the width of the line formed on the photographic plate depended in part upon the relation between the velocity of the different rays emitted. Other factors affecting this width were investigated, various possible distributions of velocity were considered, and it is shown that it is necessary to measure the ratio between the intensity at the middle of the line and that at its edges. The final result is that there is no indication of any difference in the initial velocities; if it is assumed that the velocities are distributed uniformly between two limits, the extreme difference cannot be more than 0·3 per cent. If, on the other hand, the velocities are assumed to be distributed about the velocity V according to the probability law, 75 per cent. of the rays have velocities which differ by less than 0·3 per cent.

THE THERMAL EXPANSION OF HALIDES OF THE ALKALI METALS AT VERY LOW TEMPERATURES.—A series of measurements, carried out in collaboration with Frl. H. Krüger and Messrs. H. Wiens and J. Hähnel, is described by Frl. A. Henglein in the *Zeitschrift für physikalische Chemie* of February 25. The densities of sodium and potassium chlorides, bromides, and iodides were determined by the pyknometer method at 0° C. and −79° C., and it was found that salts prepared by fusion have a higher density than those crystallised from aqueous solution. The density was also determined with a gas volumometer at room temperature, 0° C., −70° C., and −184° C., the accuracy attained being about ±0·5 per cent., using about one gram of salt. The densities are tabulated, those of sodium chloride together with the values of r, the distance between the centres of unlike ions of this substance and the mole volumes being given in the following table:

Temp.	Density.	$r \times 10^8$ cm.	Mole Volume.
0	2·168	2·813	26·97
−79°	2·186	2·805	26·74
−184°	2·208	2·796	26·48
−273°	...	2·793	26·41

Grüneisen's law (atomic heat/coefficient of expansion is a constant for all temperatures) holds, so that it is possible to calculate the moleculer volume at absolute zero, and so find v at that temperature. The percentage alteration of the molecular volume from 0° to absolute zero is for sodium chloride, 2·1; potassium chloride, 2·1; potassium bromide, 2·3 per cent, or nearly the same number. When the cation remains the same, the coefficient of expansion increases with increased atomic weight of the anion; when the anion is the same, the coefficient diminishes with increased atomic weight of cation

ALTERNATING CURRENTS AND OVER-VOLTAGE PHENOMENA.—S Glasstone, in the April issue of the Journal of the American Chemical Society, records some observations on the effect of small alternating currents on cathodic and anodic over-voltage for a series of metals in normal acid and alkali The results indicate that only in a limited number of cases does alternating current of small amplitude reduce the polarisation at such electrodes A possible explanation of this reduction is discussed.

ATOMIC SPACING IN ORGANIC COMPOUNDS.—The results of X-ray investigations on saturated aliphatic ketones and hydrocarbons are recorded in the March number of the Journal of the Chemical Society The work, which was carried out by W. B Saville and G Shearer in the case of the ketones and by A Muller and W B. Saville in the case of the hydrocarbons, shows that a study of the X-ray spacing gives an indication of the number of carbon atoms in ketones, and a consideration of the intensity distribution enables the position of the carbonyl group to be located within fairly narrow limits. All the (normal) hydrocarbons which were examined exhibited two typical sets of spacings, one, relatively large, increasing linearly with the number of carbon atoms in the molecule, and the other very nearly independent of this number The increase per carbon atom of the long spacing is too large to be accounted for by the longest of the tetrahedral chains; some additional variable must be introduced to explain the behaviour. Octadecane, $C_{18}H_{38}$, and eicosane, $C_{20}H_{42}$, appear to exist in two crystalline modifications

VISCOSITY AND ALLOTROPY OF GLASS.—The March issue of the Journal of the Society of Glass Technology contains a paper on the viscosity and allotropy of glass, by H le Chatelier M le Chatelier gives a theoretical discussion of the work of Washburn and Shelton and of English, and finds that the results of these workers may be expressed by the relation $\log(\log \eta) = M(t - 1000)/1000 + N$, where η is the viscosity, M the rate of variation of η as a function of temperature t, and N is the viscosity at 1000°, *i e* in the middle of the working zone of glass The greater N is, the harder is the glass; the smaller the value of M, the more extensive is the range of fusibility of the glass No definite relation has been found between the chemical composition of glass and its range of fusibility, but a connexion definitely exists between composition and viscosity Glass exhibits an allotropy phenomenon similar to sulphur, with the difference, however, that in the case of glass changing its state, only the law of variation of viscosity as a function of temperature is altered, not the absolute value. There is some uncertainty as to the temperature at which the transformation takes place.

COBALT.—An account of the production and uses of cobalt, by T H. Gant, appears in *Chemistry and Industry* for February 13 and 20. The chief sources of supply are Canada and Australia, the main ores being smaltite, cobaltite, and asbolite. The latter is a mixture of metallic oxides and may contain up to 30 per cent. cobalt oxide. In Canada, the ores are worked for the small quantities of precious metals which they contain, the cobalt being recovered as a by-product The ore is smelted with a flux (*e.g* lime if the ore is siliceous), a certain amount of iron being allowed to enter the speiss, or crude arsenide, which is formed Its presence prevents the passage of cobalt into the slag in any appreciable quantity. The slag is re-smelted, the speiss is then calcined, the arsenic driven off being collected and sold The roasted speiss, which contains about 10 per cent of arsenic, is treated with hot hydrochloric acid and allowed to settle. The filtered mother liquor is nearly neutralised with lime, when nickel hydroxide and ferric arsenate are precipitated, enough iron having been added to convert all the arsenic to this compound in the acid treatment stage The remaining arsenic and copper are removed by sulphuretted hydrogen, or, in the latter case, electrolytically The solution now contains only cobalt and nickel chlorides, the former is precipitated by adding just the correct quantity of lime and the nickel solution, after separation, is precipitated by adding further quantities of lime. This method of separation of these metals has a very interesting history. The metal is obtained from the oxide by mixing the latter with a starchy material and heating to a high temperature in a retort. The principal and oldest use of cobalt oxides is in the ceramic industry, they are used as stains, either body stains, glaze stains, or under-glaze stains. Certain salts (*e g.* hydroxide, borate, oleate) are finding use as driers, certain organic salts of cobalt are the most efficacious and convenient driers known. Cobalt, in the form of smalt, is also used for colouring enamels blue, and the oxide is used to neutralise any yellow colour in a white enamel caused by iron oxide Electroplating with cobalt solutions seems to be more satisfactory than with nickel, the plating occurs much more rapidly and a lesser weight of hard cobalt deposit offers the same protective coat as a greater weight of the softer metal.

INDUSTRIAL ILLUMINATION.—Within recent years much attention has been directed to the rapidity with which operations involving vision can be accomplished under various intensities of illumination. The General Electric Co of America has published in the Journal of the Franklin Institute for April a paper on this subject by P W Cobb, who is a psychologist, and F K Moss, who is a physicist. A large number of experiments were carried out and definite curves connecting brightness with mechanical precision were obtained. Extreme values of brightness were not used, so the problem is not complicated by the introduction of glare The results of this investigation prove that for accurate mechanical work the brightness must exceed a definite value. They can consequently be applied directly to many industrial operations When the output is on a quantity production basis and the various operations follow one another at fixed and predetermined intervals, the gain in accuracy shown by the laboratory experiments in increasing the brightness to the definite value would be realised in practice. It has been objected that the better illumination induces the workers to function their eyes at an unnatural rate and so they would be more fatigued at the end of the day. The evidence, however, does not support this objection. Eye fatigue is not generally experienced in daylight, where the illumination is generally several hundred times that of present artificial lighting.

The Fat Soluble Vitamins and Irradiation in Nutrition.

OUR knowledge of the properties and effects of those elusive accessory food factors, usually designated by the term "vitamins," is gradually being extended by the labours of a large number of research workers. a short account of some of the more recent work on the fat soluble vitamins may prove useful, both from its intrinsic scientific interest and also from the influence it may have on the practical problems of human and animal dietetics. No discussion of this subject nowadays would be complete without mention of the effect of irradiation with ultra-violet rays as a substitute for, or a generator of, the fat soluble vitamins, or of the influence of these factors in the prevention and cure of rickets

The animal organism is dependent for its supply of fat soluble vitamin-A upon the vegetable world: two most important sources are the fresh green leaves of many plants and the liver of fishes, where the vitamin obtained from the food is concentrated in association with the fat (cod liver oil). Now its presence in green leaves and the effects of irradiation to be considered later have suggested that its synthesis may be effected only or chiefly in the presence of light, but Ethel M Luce and Ida S Maclean (*Biochemical Journ*, 1925, vol 19, p 47) have concluded that it can be formed by yeast cells in the absence of sunlight. it can easily be extracted from the dried yeast by ether

Vitamin-A is characterised by being associated with the fats of both plant and animal tissues, but it frequently happens in modern life that it is precisely these two types of foodstuffs which fail to reach the consumer in a fresh or natural condition Appropriate sources of the vitamin for human consumption are green leaves, milk and butter, and cod liver oil · but the leaves are frequently cooked, the milk may contain little of the vitamin to start with, and still less after the treatment it may undergo before consumption, margarine may replace butter in the diet, whilst raw cod liver oil is unpalatable without further treatment. What factors may destroy the vitamin and how may this destruction be avoided? How may an adequate supply be ensured in the human diet?

It is known that the fat soluble factor is easily oxidised, especially at a high temperature · but in an atmosphere free from oxygen it will withstand a temperature of more than 100° C. without much loss of its activity. S. S Zilva (*ibid.*, 1924, vol 18, p 881) has shown that the hardening of cod liver oil in the absence of oxygen does not result in the destruction of the vitamin: this fact may have an important bearing on the preservation of the factor in margarine, which is largely made from hardened oils. Most often, however, the vegetable oils used contain little or none of the vitamin before the hardening process takes place. Storage alone, for example of cod liver oil, does not result in complete destruction although the activity of the oil gradually becomes less: the presence of the vitamin in a sample thirty years old has been detected by E. Poulsson (*ibid.*, 1924, vol. 18, p. 919).

Since animals do not form vitamin-A, it is important to see that animal products used as food should come from animals which have had an abundant supply of the vitamin in their diet. The most important products in this connexion are undoubtedly milk and its derivatives. Ethel M. Luce (*ibid.*, 1924, vol. 18, p. 1279) has compared the effects of sunlight and a diet rich in vitamin-A in producing a milk rich in this factor. At this point we must digress for a moment to mention that the methods of testing for the presence of the vitamin by feeding animals on a diet deficient in the factor supplemented by the product under test have led to the conclusion that there is probably more than one fat soluble vitamin in existence one is concerned with the *growth* of animals whilst the other keeps this growth in normal channels, the former may be called the *growth* factor (or vitamin-A) and the latter the antirachitic factor. Luce has found that cow's milk only contains the growth factor when it is present in the food of the cow, but that exposure of the animal to sunlight whilst on a diet deficient in vitamin-A increases somewhat the content of the antirachitic factor in the milk, the amount of this latter factor is, however, increased much more by the presence of fat soluble vitamins in the cow's diet The quantity and fat content of the milk are not apparently increased by a diet rich in vitamin-A, from some experiments on goats by E. T Sheehy (Proc Roy Dublin Soc, 1924, vol 17, p. 333)

The study of experimental rickets has shown the importance of the fat soluble vitamins in the etiology of this disease, but it is probable that other factors are concerned as well The question is complicated by the fact that rickets is a disease of growth and may not be developed if the animals are on a diet from which fat soluble vitamin-A has been excluded, the animals on this diet ceasing to grow If the diet is simply deficient in the vitamin, so that growth does occur, then rickets will also appear S S Zilva, J Golding, and J C. Drummond have recently shown this to be true also in the case of young pigs (*Biochem Journ*, 1924, vol 18, p 872) On the other hand, if young animals are fed on a diet which, besides being deficient in fat soluble vitamins, is badly balanced as regards the proportion of its mineral elements, or deficient in calcium or phosphorus, rickets can be produced fairly easily, although growth may be also retarded This conclusion shows that it is essential to consider not only the vitamins but also the other elements of the diet, especially the minerals, in connexion with this disease

Attention must be directed to a further factor which influences the development of rickets The animal body seems able to store a supply of the fat soluble vitamins, so that until this store has been exhausted, exposure to a deficient diet will be without effect The amount in this store will obviously depend on the diet given before the experimental period commenced, and it has been found that the diet of the mother during pregnancy and lactation has a marked influence in this respect, a conclusion which has an obvious practical bearing on human dietetics. Thus V. Korenchevsky and Marjorie Carr (*Biochem. Journ.*, 1924, vol. 18, pp. 1308, 1313, and 1925, vol. 19, p. 112) have shown that if the mother's diet is deficient in fat soluble vitamins during pregnancy and lactation, the young (rats) placed on a deficient diet at weaning develop rickets more easily than those whose mothers had been fed on a rich diet during corresponding periods. An excess of calcium in the mother's diet, provided that the fat soluble vitamins are in excess also, still further improves the resistance of the young to the development of rickets afterwards. If the parent rats of either sex are fed on a deficient diet before mating, the animals are less fertile, and the young born are weaker than normal, but there is no sign of any deficiency of calcium in their skeletons; thus the mother draws on her own reserves for the sake of her young.

Once rickets has developed on a deficient diet, it has been of interest to determine whether any

other factors besides the replacement of the missing vitamins will have any influence on the course of the disease. The addition of more calcium or phosphorus to the diet has little effect, unless these elements are already deficient; but V. Korenchevsky and M Carr (*ibid*, 1925, vol. 19, p. 101) have found that the subcutaneous injection of calcium glycerophosphate may improve the calcification of the animals on the deficient diet; the injection of sodium phosphate alone was almost without effect. Apparently only a certain maximum amount of calcium can be absorbed from the digestive tract, but that this is probably not due to the absence of the vitamins from the diet is shown by the results of some experiments by Katharine M. Soames (*ibid*, 1924, vol 18, p 1349), the intraperitoneal injection of cod liver oil in rats afforded some protection against rickets; presumably these vitamins exert their influence on the tissues after absorption and do not facilitate the absorption of other elements of the diet. The same author in collaboration with R. Robison (*ibid*, 1925, vol 19, p. 153) has investigated further the cause of the deficient calcification of the bones in rickets They find no deficiency in the blood of the phosphoric ester hydrolysable by the bone enzyme or of the enzyme itself in the bones The administration of cod liver oil has no effect on this ester or on the enzyme, but increases the organic phosphorus present in the blood. It only influences the inorganic phosphorus of the blood when the diet is deficient in this element. The inference from their results is that the deficient calcification on a diet deficient in the fat soluble factor alone is due to a deficiency of calcium ions, deficiency of phosphorus only plays a part when the diet is deficient in this factor also.

A further factor in the cure or prevention of the effects produced by a diet deficient in fat soluble vitamins has been found within the last few years in the influence of ultra-violet rays In the earlier observations children suffering from rickets were exposed directly to the source of light, with the result that the bone lesions were healed; the subject was taken up experimentally later and it was found that the growth of rats could also be stimulated by ultra-violet light when the animals were fed on a diet deficient in fat soluble vitamins. Later work has suggested that the ultra-violet rays may cause a synthesis of the antirachitic factor, but only a mobilisation of the body's store of vitamin-A without a true synthesis. This agrees with the results of Luce and Maclean mentioned above, who conclude that light plays no part in the formation of vitamin-A. Some of the other effects of irradiation have recently been referred to in these pages (December 20, 1924, p. 901, and May 2, 1925, p. 642).

A further step from this work was the examination of the effects of the ultra-violet rays upon the *food* given to the animal, and S. J. Cowell (*Brit. Med Jour*, 1925, vol. 1, p. 594) has tried the effect of feeding irradiated milk to rickety children; his paper also gives a brief account of some of the earlier work on irradiation He has found that the irradiated milk has produced a great increase in the calcification of the bones of two children with rickets, whilst a third fed on the same milk without irradiation showed very much less improvement It appears then that the antirachitic factor can be synthesised outside the body under the influence of ultra-violet light, this conclusion is of great importance, since it implies that a further method is available for the improvement of a ration which we may suspect to be deficient, it also opens up the way to a knowledge of the chemical constitution of the antirachitic factor and possibly its supply in some convenient and more palatable form than cod liver oil.

Further information as to the use and effects of light treatment in disease, together with accounts of the physiological actions of ultra-violet radiations, may be found in articles by J H. Sequeira and W. J. O'Donovan (*Lancet*, 1925, vol. 1, p 909) and F. H. Humphris (*ibid* p 912)

Power Alcohol from Root Crops.

THE third memorandum of the Fuel Research Board on fuel for motor transport[1] deals with the production of power alcohol from tuber and root crops in Great Britain. Potatoes, mangolds, and Jerusalem artichokes are the only practicable raw materials which could be grown for this purpose, but it seems unlikely that potatoes would prove of economic value in this respect One ton of potatoes produces 20 gallons of 95 per cent. alcohol, so that every pound sterling it costs to grow a ton of potatoes is equivalent to 1*s*. on a gallon of alcohol for raw material alone. Co-operation between the potato grower and distiller has been suggested as a means of utilising the distillery residues for cattle-feeding, and so reducing the net cost of the power alcohol. In the southern counties the mangold is superior to the potato in that it is easier to grow, harvest, and store, and is less liable to disease and failure, while the manufacture of alcohol from it is simpler as the carbohydrates are in the form of sugar. The comparative cost per gallon for the raw material works out at 7*s*. for potatoes and 3*s*. 9*d*. for mangolds. The latter cannot, however, be grown in the north of England and Scotland owing to its susceptibility to frost The distillation residues would appear to have considerable value as an ingredient in a feeding material rich in carbohydrates but poor in protein.

The Jerusalem artichoke will grow in almost any well-drained soil, and as it is difficult to clear the ground completely when harvesting, no replanting is needed for many years when once a plot is well established, the cultivation being thus reduced to a minimum. The crop yields are very variable, probably being about 10-12 tons per acre in England, and 15-25 gallons of 95 per cent. alcohol per ton of tubers have been produced. Experiments also indicate that by using an organism of the *Bacillus butylicus* group, about 12 gallons of mixed butyl alcohol and acetone can be obtained. The simultaneous fermentation of the tubers by yeast and the same organisms yielded a liquor consisting of 70 per cent. of ethyl alcohol, 10 per cent. of acetone, and 20 per cent. of butyl alcohol. The sun-dried artichoke stalks can be so treated as to give a pure resistant cellulose at the rate of about ½ ton per acre, of a type that would be very suitable for certain purposes.

The memorandum concludes with a series of tables setting forth the results of cultivation experiments together with various analytical figures.

[1] Department of Scientific and Industrial Research: Fuel Research Board. Fuel for Motor Transport: Third Memorandum. Power Alcohol from Tuber and Root Crops in Great Britain. Pp. vi+37. (London: H M. Stationery Office, 1925.) 9*d*. net.

Ascent of Beerenberg, Jan Mayen.

THE island of Jan Mayen in the Greenland Sea has been known at least since the early seventeenth century, when it was much frequented by whalers, and was the site of the Austrian meteorological station of 1882–83. The Austrians made an unsuccessful attempt to reach the summit of the volcanic peak of Beerenberg, being foiled by bad weather. In the summer of 1921, the Norwegian meteorological service sent an expedition to Jan Mayen to erect a wireless station. This afforded a passage to Dr. P. L. Mercanton, who was anxious to climb Beerenberg. He was joined by Mr. J. M. Wordie, Mr. T. C. Lethbridge, and three other Cambridge men. In *Écho des Alpes*, No. 8 (Lausanne), 1924, Dr. Mercanton gives an account of the successful climb.

The mountain arises at the north-east end of the small island, and although records occur of volcanic activity on the island in 1732 and 1818, there is no evidence that the main crater has been active during historic times. Certainly there is no sign of recent lava flow. The party ascended the mountain from the south-west by Ekerold Valley over barren ground strewn with volcanic tombs, and passing to the west of Esk or Vogt crater, reached the frontal moraines of the summit glacier at about 2770 feet The route was then over a gentle ice slope without crevasses to a prominent nunatak at 5249 feet. This was marked by a cairn probably erected by the Austrians as a survey mark Higher up, a crevassed surface was encountered, but the only real difficulty seems to have been when the bergschrund was reached At 7448 feet the rim of the ice-filled crater was reached. This crater is about half a mile across, and from a gap on its northern side the Weyprecht glacier falls to the coast.

Beerenberg has two peaks, of which the higher is on the western side of the gap This was reached along a snow *arête* Dr. Mercanton gives the summit height as recorded by aneroid as 7661 feet (2335 metres). The figure obtained by the Austrians by theodolite measurement was 8350 feet (2545 metres). This may be compared with Mr. Wordie's figure of 8090 feet, which was also obtained by aneroid reading. The discrepancies between these figures are considerable, but the Austrian figures are not without doubt, largely because they worked with a very small angle The paper is illustrated by a number of excellent photographs of the mountain and a reproduction of the Austrian map.

University and Educational Intelligence.

BRISTOL.—Their Majesties the King and Queen will open the new wing of the University on June 9. The new buildings are the gift of Sir George Wills and the late Mr. H. H Wills, in memory of their father, and consist of an imposing tower and a building housing the administrative departments of the University, the main library of the Faculty of Arts and the medical works presented by the Bristol Medical and Chirurgical Society, as well as a number of lecture rooms. The provision of new accommodation for the Faculty of Arts releases a number of rooms adjoining the geological and biological departments, which will thus be afforded much-needed space for expansion.

CAMBRIDGE.—A grant of 25*l.* has been made from the Balfour Fund to Mr. J. T. Saunders, Christ's College, for an investigation of the diurnal movements of the zooplankton of the Swiss lakes. Dr. H. S. Pruthi, Peterhouse, has been nominated to use the University Table at the Zoological Station at Naples for one month.

Mr. D. Keilin, Magdalene College, has been appointed University lecturer in parasitology. Mr. J. A. Carroll, Sidney Sussex College, Assistant Director of the Solar Physics Observatory, has been appointed University lecturer in astrophysics.

The following grants have been made from the Worts Fund:—100*l.* to G. E. Barton, Gonville and Caius College, towards the expenses involved in a visit to Sumatra and elsewhere to complete a study of limestone denudations and other subjects, 100*l.* to A. B. Deacon, Trinity College, towards the expenses involved in a visit to the New Hebrides for ethnological study; 40*l.* to W. G East, Peterhouse, for a visit to Vienna to inspect certain Foreign Office documents in connexion with historical research; 30*l.* to J. Needham, Gonville and Caius College, for researches on the oxidation-reduction potential of the cell-interior to be carried out at Roscoff in Brittany

LONDON.—The three following courses of free public lectures have been arranged. "The Biological Aspect of Hydrographical Work," by Dr J Schmidt, at University College, at 5.30 o'clock, on June 8 and 9, "Blood and Circulation from the standpoint of Physical Chemistry," by Prof L J Henderson, at University College, at 5 30 o'clock, on June 10, 11, and 12, and "Cardiology," by Prof J Hay, at University College Hospital Medical School, at 5 o'clock on June 11, 12, 18, and 19.

OXFORD.—An election to a fellowship in physiology at New College will take place in October Particulars and the necessary form of application may be had from the Warden, to whom the completed form must be returned not later than June 15.

ST ANDREWS.—The University Court has appointed Mr. David Jack, at present associate professor in the Carnegie Institute of Technology, Pittsburgh to be an assistant in the Department of Natural Philosophy.

THE Carnegie Trust for the Universities of Scotland will announce in July next the allocation for the five years 1925–26 to 1929–30 of grants to universities and extra-mural colleges. For the quinquennium now expiring these grants amounted to 224,600*l.*, including 25,000*l.* for libraries, 156,000*l* for new buildings and permanent equipment, and 43,000*l* towards endowment of lectureships and other general purposes. Special additional grants were made last year towards the equipment of two hostels for women students at Glasgow (5000*l*) and for the furnishing and equipment of a women students' union at Aberdeen (1500*l.*). Grants in 1923–24 for post-graduate study and research, including fellowships, scholarships, and grants-in-aid, amounted to 18,287*l.* Assistance for students (average 12*l.* each) amounted to 54,000*l.* and voluntary refunds to 1126*l.* A table of refunds since 1901 shows that the maximum (1623*l.*) was reached the year after the War.

APPLICATIONS are invited by the London County Council for two Robert Blair fellowships in applied science and technology, each tenable for one year and each of the value of 450*l.* The fellowships are for advanced study or research, tenable in the dominions, the United States or other countries. They are open only to British subjects. Further information and the prescribed application form (T.2.a 300) may be obtained from the Education Officer (T.2.a), The County Hall, London, S.E.1, upon receipt of a stamped addressed envelope. Completed forms must be returned by June 30.

IN our issue of February 21, p. 284, announcement was made of the foundation, by the Commonwealth Fund, New York, of twenty fellowships for British graduates. The fellowships are tenable for two years in American universities and are each of the annual value of about 600*l*. The committee of award has now issued the first list of appointments The distribution of the new fellows among British universities, including two institutions where a fellow has worked at two, is as follows: Oxford 6, Cambridge 4, Edinburgh 4, St Andrews 3, Durham 2, and Belfast, Leeds, London, Manchester, and University College, Swansea, one each Grouping the new fellows according to subject studied, the following are included economics, geology, mathematics, medicine, chemistry and physics, two each, and engineering chemistry and botany, one each The American universities to which the fellows will go are Harvard, Yale, Princeton, Columbia, Johns Hopkins, Cornell, and the universities of Pennsylvania, Chicago, Wisconsin, Minnesota, and California

ON Saturday, Principal W M Childs, speaking at University College, Reading, upon the occasion of the annual conferment of the associateship of the College, announced that a letter had been received from the Clerk of the Privy Council stating that the Lords of the Committee of Council, after considering the further petition of the College for a charter under the title of the University of Reading, were prepared to recommend the grant of a royal charter by His Majesty in Council, subject to an assurance by the petitioners that they would take all possible steps to relieve the College of indebtedness and to increase still further its present income The announcement was received with great enthusiasm by a large and representative audience Speaking afterwards at a luncheon to the newly enrolled associates, the Principal stated that already, since the petition of the College was forwarded in January last, the income of the College had been substantially increased.

ON Tuesday, May 26, Sir Robert A Falconer, President of the University of Toronto, delivered a lecture at the University of Edinburgh on "The United States as a Neighbour—Manners of Life and Thought" This was one of the lectures for 1925 of the Sir George Watson chair of American history, literature and institutions. Sir Robert Falconer discussed the effect of the environment of the new world and instanced the struggle which the settlers had in the new conditions of life, out of which issued virtues which have been reproduced in their descendants who kept moving out into the unknown regions of the West. The common school has been from early days one of the most powerful influences for the moulding of the character of the American people, among whom there is a deeply rooted conviction that the freedom of their democracy depends upon their education. On the whole, however, there is less freedom of speech than in Britain. The common school system in Canada took much from the practice and organisation of the schools of Massachusetts and New York, but was adapted so as to meet local requirements. In secondary education also Canada has adopted the American system, but Sir Robert stated that the results are not altogether satisfactory, pupils enter upon their high school work some two years too late, so that those who go on to the University at eighteen do not possess the liberal training necessary for recruits to the learned professions The tie of a common language he considered to be the greatest and best of all influences moulding the life of Americans and Canadians to similar issues.

Early Science at Oxford.

June 7, 1687. A letter from Mr. Humphrey to Mr. Lloyd, dated Lhandowhyn May 26, 1687 giving an account of some Natural Curiosities from Anglisy was communicated

Mr Molineux his letter to Dr. Plot desiring some accompt of the great fall of Thames near London Bridge on May the 10th, which occasioned the Doctor to inform the Society that himself saw horses and also boys of 12 or 14 years of age pass ye River, that three parts of ye Channel was without water The manifest cause of which was ye violence of the Winds which then blew at S W.

Nux de Bhen, yeilding an oyl much used by painters, and Semen Macalep, used in perfuming of gloves both from E Indies, were communicated by Dr. Plot.

June 8, 1686. A Letter from Dr Bagley to Mr. Musgrave was read; giving an account of the *Dissections* of four bodys.

Dr Plot shewed the Society, the Curiosities following A peice of Corktree nine foot long, and about five inches diameter, which grew in Cambridgeshire; A small stone changing colour according to the different reflections of light, appearing green and sometimes blackish, Oyl of Camphire made with water, A Liquor distilled from some bituminous strong scented earth digged at Hogsdon in Midlesex; *Labdanum liquidum* of a greenish colour

June 10, 1684. Dr. Plot acquainted ye Society, that, haveing put some of ye *Natrôn* into a glass about a month since, he observed, that, at ye beginning of June, it was somewhat encreased in weight. He presented ye Society with a spirit of this salt mixed with salt of tartar; it was very volatile, urinose, and had something of an oilness in its tast He mentiond severall other experiments, which he had tried on this salt, but haveing not as yet put his last hand to them, he was desired to prosecute them, as he shall thinke fit; and bring in an account of them, when completed

Dr Plot also brought in an account of ye *weather* ye last month here at Oxon, taken according to Dr. Lister's Scheme: if this design be carried on, in ye severall quarters of ye land, it will inform us more particularly as to ye coasting of winds, and how rains etc depend on them. He also presented to us a pattern of a very rich *Gold-ore* from Hungary, lately presented him by Mr Lawson, a Dane; it was of that sort, which is termed *Aurum statim suum*; it needs no refining, but may easily be separated from ye alabastine substance, with which it is mixed, barely by powdering.

Dr. Smith communicated, and read, a discourse *de Longitudinum differentiis inveniendis*, composed many years since, by Dr. John Bainbrigg, formerly Savilian Professor in this University.

June 12, 1688. A Certificate from Mr. Morgan Jones a Minister, dated at New York Mar. 10th 1685–6. was read concerning some Natives of the West Indies near Cape-Ahas that understand the British Tongue.

A letter from Mr. Hillyer to our President dated Jan. 3. 1687–8. was read, which gave a large account of the country of Cape Corse in Guinea and of some customes of the natives there.

Dr. Plot communicated a stone that was brought out of Cornwall called the Soap-stone.

Mr Musgrave gave an account that a very good sort of Vinegar is made thus; put 2 lb. of the best Mallaga Raisons cleansed into a gallon of spring water in an earthen jar covered with a slate and set in the sun for about two months in the heat of summer, or till it is sharp enough, then draw it off with a syphon without jogging.

Societies and Academies.

LONDON.

Royal Society, May 28.—R. J. **Ludford**: (1) Cell organs during secretion in the epididymis. The Golgi apparatus hypertrophies and assumes different forms, according to the degree of secretory activity. There occur nucleolar extrusions, nuclear budding, and a differential staining of the nucleolus, while the mitochondria increase in number at the onset of secretory activity, and decrease during the course of secretion. Variations observed in the secreting cells in different tubules of the epididymis are probably indicatory of variations in the degree of intensity of the secretory process. Secretory activity is maintained by the elimination of waste products, which is effected by nucleolar extrusions from the nucleus, and by amitosis followed by the discharge of a nucleus and part of the cytoplasm into the lumen of the tubule. Reconstruction of exhausted cells also occurs during a resting phase, while cells completely worn out are replaced, principally by the basal cells. (2) Nuclear activity in tissue cultures. The nucleoli of fibroblasts of the rat's kidney perform during life slow amœboid movements. Occasionally a nucleolus approaches the inner surface of the nuclear membrane, and part of it is discharged into the cytoplasm, where it disintegrates. Also, a portion of the nucleus itself may be budded off, persist for a time, and then diffuse into the ground cytoplasm. These processes probably represent phases in the normal metabolic activity of the cell.—J. **Needham** and Dorothy **Needham**: The hydrogen-ion concentration and the oxidation reduction potential of the cell interior: a micro-injection study. Subject to certain assumptions, the cell-interior of *Amœba proteus* has a hydrogen-ion concentration of approximately P^H 7·6, and an oxidation reduction potential of between *r*H 17 and 19.—F. W. R. **Brambell**: The oogenesis of the fowl (*Gallus Bankiva*). The Golgi apparatus, type 1, of the oocyte is demonstrated for the first time. It is shown to surround the centrosphere. An intrusion into the oocyte of Golgi apparatus, type 2, from the follicle cells takes place. The former, and possibly the latter, break up into fine granules and become dispersed throughout the cell during oogenesis. These granules probably persist as such, and produce the Golgi apparatus of each embryonic cell by a process of condensation. The mitochondria increase in number in the oocyte and form the *mitochondrial cloud*. The transitory *mitochondrial yolk-body* differentiates in the middle of this cloud. At a certain stage between the third and sixth week after hatching, a number of oocytes in the ovary of the chick enter upon a period of precocious growth, exhibiting remarkable abnormality in behaviour of their cytoplasmic inclusions and finally becoming atretic. This may represent the final degeneration of the primordial germ-cells.

The Optical Society, April 16.—J. **Guild**: The geometrical solution of colour mixture problems. Starting from the experimental fact that any colour can be uniquely expressed by a trichromatic equation, provided negative coefficients may enter, all problems of colour mixture are amenable to an exact system of geometrical calculation. The methods used obviate the introduction of stereographic projection and other geometrical complications. This simplification is effected by conducting the actual colour mixture part of any calculation in the quantity units of one trichromatic system, leaving the relative magnitudes of the various systems of units, where more than one system is involved, to be accounted for by the introduction of suitable coefficients in the purely arithmetical part of the work.—J. W. **Gordon**. "The double square"—a new optical appliance based upon the "optical square". The optical square is a well-known arrangement of two mirrors for deflecting an optical axis through a right angle and obtaining an erect image. The double square is formed by the addition of a third mirror, which gives an inverted image and is so disposed with regard to the first two as to enable the image to be seen in adjacent but concentric fields, the one image simply reversed and in juxtaposition to the other. Such a combination may be used as an artificial horizon in the taking of altitudes or as a gun sight and is applicable to the sextant and the range-finder.—F. Van **Neck**: (1) The Hahn Goerz workshop microscope. This instrument is a shortened prism microscope giving an erect image of the object. A magnification of between 35 and 55 diameters is obtainable, the variation being effected by extending the ocular tube. An open sight is provided, by means of which the microscope can easily be directed to any particular spot. The microscope is carried on a horizontal bar which can move up and down on a vertical pillar, and movement in any direction is possible. The instrument can be used for examining objects of any kind which cannot be brought on to the stage of an ordinary microscope.—(2) The "Artisol" mirror arc lamp. This lamp is specially intended for the projection of cinema films. The carbons are at right angles to one another, the crater being directly exposed to the parabolic glass mirror. The light reflected from the mirror is collected by a large plano-convex lens. The arrangement of the carbons and the combination of glass mirror and large condenser ensures a much higher illumination per unit of current than in the ordinary pattern lamp.

Linnean Society, April 23.—R. J. **Chittenden**: Primula hybrids. The F_1 between *P. acaulis* and *P. Juliæ* has a pink corolla, while those between *P. Juliæ* and *P. elatior* and between *P. Juliæ* and *P. officinalis* have the corolla yellow. A dominant colour inhibitor seems to be present in *P. elatior* and *P. officinalis* and absent from *P. acaulis*. These facts suggest that the garden Polyanthus may have risen from *P. acaulis* and *P. officinalis* or *P. elatior* hybrids by recombinations of their various factors.—M. A. C. **Hinton**: A vole from Montenegro, discovered in December 1921 by Dr. V. Martino. Martino's vole is a large species (head and body 130 mm.; tail 101, hind-foot 25·4; ear 18·5), long tail. In colour it is brownish-grey above when adult, bluish-grey when young, whitish below. Its feet are white and its tail conspicuously bicoloured, dark brown above, white below. It is referred to the genus Dolmys, described and hitherto only known from the Upper Pliocene of Hungary. Martino's vole is named *Dolomys bogdanovi*. The remarkable external characters and the extreme brachyodonty are generalised features of an archaic form which has managed to linger in Balkan seclusion.—John **Parkin**: A unique feature in the petal of Ranunculus, and its bearing on the phylogeny and taxonomy of the genus. Möbius, forty years ago, explained the cause of the high polish exhibited by the petals of yellow buttercups as follows: The upper epidermis of the petal has a perfectly smooth external surface, and its cells hold the yellow pigment in solution as a kind of oil. Below the epidermis is a layer of cells densely packed with minute starch grains. The whole structure is like a mirror. The epidermis with its clear yellow liquid acts as the gloss, and the starch layer as the reflector. This is substantially correct. Species with

glossy petals form a natural group, and most seem to have yellow flowers The presence of starch in a few of the non-glossy species presents a difficulty in phylogeny. Perhaps starch in the mature plant is, as a primitive feature, retained and used as an adaptation in the species which have developed glossiness The high polish of the petal of the yellow buttercup has been of advantage in attracting insect visitors to the flower, and thus been partly responsible in making this section of the genus, in contrast to the white group, cosmopolitan —Kenneth **Rees**: Previous investigations into the distribution and ecology of marine algæ in Wales.

Faraday Society, April 27.—E. A **Ollard**. Adhesion of deposited nickel to the base metal This work was undertaken to endeavour to measure the adhesion of deposited nickel to mild steel A special method was evolved, the result of which shows an adhesion probably greater than 19 tons to the square inch.—H. **Sutton** The brittleness of zinc-plated steel Stream-line wires are embrittled by zinc plating. A deposit of zinc of not more than 0·0005 in. affords good protection against corrosion and permits the easy removal of the brittleness Both cyanide and sulphate baths may be used, but the former is preferred on account of the superior protective qualities of the deposit In either case the wires should be heated to 100° C for thirty minutes A rough surface before plating leads to severe embrittling and impairs the recovery —W A **Naish** The partition of silver between lead and zinc Melting was carried out in clay cylinders in a metal bath, heated electrically and with adequate stirring and temperature measuring arrangements, the cylinders being quenched in mercury. In dilute solution there is a distribution ratio $\left(\frac{\text{Per cent Ag in Zn}}{\text{Per cent Ag in Pb}}\right)$ of approximately 302 at 550° C.; this is independent of the concentration of silver or the relative proportions of lead and zinc, but is dependent on the temperature, the deviation at higher concentrations than about 5 per cent silver being probably due to the formation of compounds.—H. J. **Poole** The elasticity of gelatin jellies and its bearing on their physical structure and chemical equilibria The strain produced in gelatin jellies by the application of a steady stress is not a function of that stress alone but is governed by a time factor The study of this time factor or "creep" suggests that the jellies are two-phase (solid-liquid) bodies. The creep is mainly due to a reversible flow of the liquid phase in the interstices of the solid phase and, to a lesser extent, to an irreversible plastic deformation of the solid phase The solid phase is thought to have the form of a mesh of cylindrical fibrils or threads, and the material of these threads is in dynamic equilibrium with the water of the liquid phase, as a result of either a reversible hydrolysis or hydration, whereby the ratio of gelatin in the solid phase to that in the liquid phase becomes progressively less with rising temperature —D. B **Macleod** (1) On some physical properties of water. The gain in volume, assumed to be due to association of the molecules in water, and the loss of free space, bear a simple relation to the change of association, and these two facts are used to explain all the anomalies of water connected with volume, compressibility, and viscosity. (2) On the relation between the viscosities of liquids and their molecular weights Previously the author has shown that the viscosity of a liquid is inversely proportional to the free space within the liquid. The viscosities of liquids at a condition of equal amounts of free space relative to the total volume are now compared and show that viscosity can be interpreted as a simple function of the molecular weight. Divergence from normality is ascribed to different degrees of molecular complexity.—E K. **Rideal**: A note on the reduction potential of dicyanquinhydrone. The quinhydrone was prepared from equimolecular proportions of the quinhydrone and hydroquinine and the e.m.f. of the cell determined. The reduction potential was found to be 0·9712 volt at 25° C

DUBLIN.

Royal Irish Academy, April 27.—E. L **Hirst**, A. K **Macbeth** and D. **Traill**: The action of hydrazine on the halogen derivatives of malonamides and of acetoacetic esters Monochloro-, monobromo-, and dibromo-malonamides are reduced by hydrazine hydrate at laboratory temperature, and the halogen derivatives of substituted malonamides react on warming The case of dibromomalonamide is of interest as the final reaction product is the hydrazone of mesoxalamide. The α-chloro- and α-bromo-derivatives of ethyl ethyl-, propyl-, and benzyl-acetoacetates give as final products 3-methyl-4-ethyl-5-pyrazolone, 3-methyl-4-propyl-5-pyrazolone, and 3-methyl-4-benzyl-5-pyrazolone respectively, but halogen derivatives of ethyl acetoacetate give mixed products, the low percentage of evolved nitrogen in the last case is traced to this cause The preparation of ethyl α-chlorobenzoylacetate and its conversion into ethyl aminothiazolecarboxylate were described.

PARIS.

Academy of Sciences, April 27.—Jean **Tilho**. The order of magnitude of the variations of depth and extent of Lake Chad —A. **Bigot**: The presence of Trilobites and Archæocyathideæ in the Cambrian layers in the neighbourhood of Carteret (Channel).—Gaston **Julia**: Quasi-analytical functions and integral functions of zero order.—M. T. **Huber**: The bending of a flanged plate.—P. **Chofardet**: Observations of Orkisz's comet (1925 *c*) made at the Observatory of Besançon with the *coudé* equatorial. Positions given for April 19, 22, and 23. On April 22 the comet was estimated to be of the 8th magnitude, showing as a circular nebulous cluster, about 8′ diameter, with a strong central condensation.—H. **Eyraud**. The theory of the electromagnetic field and atomic radiation —Léon **Brillouin**: Surface tension: the intepretation of the Eötvös relation.—C. E. **Guye**, P **Mercier**, and J. J. **Weigle**: The explosive potential in carbon dioxide at high pressures. The experimental results of several years' work are given, showing the explosive potential in volts for pressures between 1 and 20 atmospheres and for distances between the electrodes varying between 0·5 and 5 mm.—R. **Forrer**: An artificial magnetic anisotropy of nickel. The phenomena of discontinuity.—E. **Estanave**: Contribution to the realisation of integral photography —H. **Ikeuti**: The beta rays produced in air by homogeneous X-rays of short wave-length. Measurements of the lengths of the trajectories of the two types of beta rays, photo-electrons, and fish tracks (C T. R Wilson). The results are in general agreement with those of Wilson and Compton.—Albert **Arnulf**: The ionisation of potassium vapour under the influence of visible light. Experiments showing that under the influence of ordinary (not ultra-violet) light a small number of electrons and positive ions are set free.—**Roger Grandgérard**. The "Bertillonnage" of modern pictures by radiography. A radiograph of a picture furnishes an exact proof of identity. It is suggested that a radiograph of a picture, taken under certain prescribed conditions, should be deposited officially, a duplicate being

retained by the artist. This would suffice to decide any question of authenticity in the future.—H. **Forestier** and G. **Chaudron**: The transformation points of solid solutions of alumina or chromic oxide in ferric oxide.—W. **Mestrezat** and Mlle. Y **Garreau**: Experimental contribution to the study of the transport of electrolytes. The mobilisation of the ions by intermolecular exchanges.—Georges A. **Le Roy**: A medieval weapon damascened with tin. Ancient weapons, inlaid with gold or silver, are well known, but inlaying with tin during mediæval times in Europe has not hitherto been noted. The epée examined by the author was found to be inlaid with tin.—Raymond **Charonnat**: The potassium chlororuthenates. The brown chlororuthenate of Claus and Rutbier and the red salt obtained by Lewis Howe have been accepted as a case of isomerism not in agreement with Werner's theory. It is shown that these two salts are not isomers, since ruthenium is tetravalent in the brown salt and trivalent in the red salts. This removes a supposed case of isomerism incompatible with the theory of Werner.—Max and Michel **Polonovski**: The oxyeserenic derivatives.—Const. **Dosios** and Theod **Tsatsas**: The nitro products of diphenylglycollic ether.—Raymond **Delaby** and Jean Marc **Dumoulin**. The isomerisation of the vinylalkylcarbinols $CH=CH-CH(OH).R$ into ethyl-alkylketones $C_2H_5.CO\ R$. Vinylethylcarbinol is converted by copper at 296° C. into the isomeric diethylketone. The next two higher homologues are similarly converted into the corresponding ketones.—F. **Kerforne**. The contact of the Vilaine sheet with its substratum.—C. E **Wegmann**: A delayed phase of the Scandinavian Caledonian chain.—A **Goris** and M. **Metin**. The chemical composition of a hybrid of *Aconitum Anthora* and *Aconitum Napellus*. The alkaloids peculiar to each species (anthorine and aconitine) are found together in the hybrid.—Paul **Gillot**: The characteristics of some oils from Euphorbiaceæ. Mercurialis and Euphorbia are not only characterised by their botanical affinities, but also by the similar physical and chemical characters of the oils extracted from their seeds. These oils are very similar to linseed oil.—E. and G **Nicolas**: Observations on the influence of urea, thiourea, and allylthiourea on the higher plants.—Edouard **Fischer**: The constitution of the green gland of the crayfish.—Lucien **Semichon**: The action of alcohol on the selective faculty of yeasts in the fermentation of grape musts.—Léon **Blum** and Maurice **Delaville**: Researches on the mechanism of acidosis.—L. **Panisset** and J. **Verge**: The presence of spirochætes in dogs attacked with hæmorrhagic gastro-enteritis.—Yves **Kermorgant**: The etiology of mumps.

ROME.

Royal Academy of the Lincei, March 15.—T. **Levi-Civita** and U. **Amaldi**: Conditions for the ensurance of the independence of the arguments in the Hamiltonian expression for varying action.—Leonida **Tonelli**: Singularity of the solution of an ordinary differential equation.—F. **Zambonini** and G. **Carobbi**: Lanthanum thallous sulphates. The three compounds, $La_2(SO_4)_3$, $4{\cdot}5Tl_2SO_4$; $La_2(SO_4)_3$, $3Tl_2SO_4$; and $La_2(SO_4)_3$, Tl_2SO_4, $2H_2O$, are found to exist.—Secondo **Franchi**: Fundamental stratigraphical and palæontological data for the secondary age of the calc-schists and the hypothesis of a great overthrust of the mass of these rocks in the Franco-Italian Alps.—Achille **Russo**: Impure gametogens, impure gametes, and accessory conjugations in *Cryptochilum echini* Maupas.—Enrico **Bompiano**: A theorem of comparison and a theorem of singularity for the differential equation $y'=f(x,y)$.—Letizia **Onali**: A theorem on the surface of the minimum order passing through an oblique curve.—D. J. **Struik**: Mathematical work of Paul of Middelburg.—Emilio **Oddone**: The resistance offered by the earth's surface to movements of the air.—G **Carobbi**: Synthetic praseodymiferous chlorovanadinite: Reference to Prandtl and Grimm's recent work on element No. 61. The author's failure to justify the assumption that praseodymium exists in a quinquevalent form isomorphous with quinquevalent vanadium furnishes no support for the arrangement of the rare earths given in Prandtl and Grimm's periodic system.—U **Sborgi**: An electronic theory of the anodic behaviour of metals, especially of those exhibiting phenomena of passivity.—U **Pratolongo**: Alkaline chlorosis of the vine. The results of preliminary experiments indicate no causal connexion between the high alkalinity of the soil or its tendency to produce chlorosis and the presence, abundance, or fineness of the calcium carbonate it contains.—Antonio **Cavinato**: Studies on quartz: Quartz crystals from Val Maggia and their interesting pseudo-hemimorphic habit.—Enrico **Clerici**: Fusion mixture for isopyknomeric analysis. Mixtures of thallium formate and fluoride give liquids of specific gravity 4·20 at 20° C., 5·38 at 100° C., and 5·40 at 110° C., such mixtures exhibit marked fluidity and pass rapidly through filter-paper.—Renato **Santucci**: Contribution to the study of the post-embryonic development of the Scyllaridea of the Mediterranean.—P **Pasquini**: First formation of the pectin in the development of the eye of *Gallus domesticus*.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 3, March).—G. L **Clark** and W **Duane**: The relative intensities of fluorescent and scattered X-rays. The scattered and tertiary radiation due to tungsten X-rays, for secondary radiators of atomic weight near that of molybdenum, are extremely weak compared with the fluorescent radiation. The source of the powerful radiation found in earlier experiments is unknown.—W. **Duane**: Note on the quantum theory of the reflection of X-rays. The assumption that only the total fluorescent radiation from an atom quantises its momentum with the crystal leads to results not justified by experiment.—G. N **Lewis**: A new principle of equilibrium. Corresponding to every individual process there is a reverse process, and in a state of equilibrium the average rate of every process is equal to its reverse process. This is termed the Law of Entire Equilibrium. In a state of equilibrium, there is no essential difference between backward and forward direction in time, time thus loses its unidirectional character.—J. C. **Walker**: Studies on disease resistance in the onion. So far as smudge and neck-rot are concerned, immunity appears to be related to the presence of flavone or anthocyan colouring matter in the outer scales. Black mould attacks both coloured and uncoloured varieties.—W. J. **Luyten**: Notes on stellar statistics; (iv) on the relation between the mean values of the v and τ components of proper motion.—Cecilia H **Payne**: Astrophysical data bearing on the relative abundance of the elements. The temperature of disappearance of a line in stellar spectra is a function of the relative abundance of the element in question (Fowler and Milne). Assuming among other things that stellar atmospheres are uniform and that the effects of nuclear fields are negligible at stellar pressures and temperatures, computations from a homogeneous collection of spectra indicate that the relative abundance of atomic species in the stars and in the earth's crust is of the same order. Zinc is an exception, and the stellar figures for hydrogen and helium are improbably high.

Official Publications Received.

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1924. Pp. ii+8 (Zomba.)

Board of Education. Report for the Year 1924 on the Science Museum. Pp. 20. (London: H.M. Stationery Office.) 9d. net.

Board of Education. Report of an Enquiry into the Conditions affecting the Teaching of Science in Secondary Schools for Boys in England. Pp. 28. (London: H.M. Stationery Office.) 3d. net.

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1924 présenté au Conseil dans sa séance du 27 février 1925. Par B. Baillaud. Pp. 28. (Paris.)

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 37: Land-Grant College Education, 1910 to 1920. Part 2: The Liberal Arts and Sciences, including Miscellaneous Subjects and Activities. Edited by Walton C. John. Pp. v + 108 + 4 plates. (Washington: Government Printing Office.) 25 cents.

The British Mycological Society. Transactions, Vol. 10, Part 3. Edited by Carleton Rea and J. Ramsbottom. Pp. 129-232. (London: Cambridge University Press.) 7s. 6d. net.

Forest Research Institute, Dehra Dun (U.P.), India: Economic Branch. Tests of Indian Timbers in Structural Sizes: Scheme of Operation No. 1 for Project No. 2. By L. N. Seaman. Pp. iii+16+5 plates. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10d.

Seale-Hayne Agricultural College, Newton Abbot, Devon. Department of Plant Pathology. First Annual Report for the Year ending September 30th, 1924. (Pamphlet No. 16.) Pp. 31. (Newton Abbot.)

Instituts scientifiques de Buitenzorg. "'s Lands Plantentuin." Treubia. Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 7, Livraison 1, février. Pp. 84+3 Tafeln. (Buitenzorg.) 2.50 f.

Memoirs of the Indian Meteorological Department. Vol. 24, Part 9. Correlation in Seasonal Variations of Weather, IX. A further Study of World-Weather. By Sir Gilbert T. Walker. Pp. 275-332. 2.12 rupees, 4s. 9d. Vol. 24, Part 10: Correlation in Seasonal Variations of Weather, X. Applications to Seasonal Forecasting in India. By Sir Gilbert T. Walker. Pp. 333-345. 8 annas; 9d. (Calcutta: Government of India Central Publication Branch.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 14, Part 1: (1) On the Chemical Constituents of Malt-rootlets with special reference to Hordenine. (2) On the Hemicelluloses of *Allium Cepa*, L. By Yoshitaka Hashitani. Pp. 68. Vol. 14, Part 2. Über die Kultur von *Aspergillus niger* mit besonderer Rücksicht auf das Puffervermögen der Nährlösung. Von Prof. Tetsu Sakamura. Pp. 85-128. (Sapporo.)

Diary of Societies.

SATURDAY, JUNE 6.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—General Discussions: Methods of Drainage of Brain-abscesses: Artificial Aids to Hearing.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District) (at Town Hall, Reading), at 11 A.M.—Discussion on Tests on the Air-Ejector Sewage System at Gosport.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (III.).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Annual Congress) (at Folkestone). (*See June 3 for programme.*)

MONDAY, JUNE 8.

FARADAY SOCIETY (jointly with Iron and Steel Institute) (at Institution of Civil Engineers), at 8.30.—The Physical Chemistry of Steel Making Processes.—Sir Robert Hadfield, Bart.: Introductory Address.—A. McCance: Balance Reactions in Steel Manufacture.—J. B. Ferguson: Equilibria in Systems involving Ferrous Oxide.—P. MacNair: Slag Reactions.—T. P. Colcough: A Study of the Reactions of the Basic Open Hearth Furnace.—J. H. Whiteley: The Function of Ferric Oxide in the Acid and Basic Open Hearth Processes.—F. T. Sisco: The Chemical Reactions in Basic Electric Process.—W. J. Rees: The Micro-examination of Steel Making Refractories.—A. L. Field: Physico-Chemical Phenomena from Melt to Ingot.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Principal Sir Alfred Ewing: A Ball and Tube Flowmeter (with experiments).—Général G. Ferrié: L'Entretien des pendules au moyen de cellules photoélectriques.—Prof. W. Peddie: A Colour Vision Spectrometer.—J. Forrest: Magnetic Quality in Crystals; Discrimination of, and Stability in Molecular Lattices.—W. L. Ferrar: On the Cardinal Function of Interpolation Theory.—Dr. D. A. Fairweather: The Electrosynthesis of n-Dotriacontane Dicarboxylic Acid.

BIOCHEMICAL SOCIETY (at St. Thomas's Hospital), at 5.—J. Patterson: The Carbohydrate Content of Normal Urine.—H. P. Marks: Some Observations on the Testing of Insulin.—Prof. R. H. A. Plimmer and J. L. Rosedale: (*a*) Study of Van Slyke's Method of Analysis of Proteins, (*b*) Experiments on Nutrition.—Prof. R. H. A. Plimmer: The Action of Nitrous Acid upon Amides and some Amino Compounds.—W. J. N. Burch: Some Esters of Phosphoric Acid.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss Mary Chadwick: The Education of the Educationist.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—A. H. Hannay, Prof. T. P. Nunn, and Prof. H. Wildon Carr: Symposium: The Subject-Object Relation in Historiography.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (Annual Meeting) (at Chemical Society), at 8.15.—Dr. A. E. Dunstan, F. B. Thole, and W. H. Thomas: Colloidics of Petroleum.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Col. C. H. D. Ryder: The Demarcation of the Turco-Persian Boundary in 1914.

TUESDAY, JUNE 9.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 4.30.—The Rt. Rev. Bishop Whitehead: Anthropology in the Mission Field.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (I.).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—C. B. Williams: Exhibition of Cinematograph Films illustrating Method of Fumigating Citrus Trees in Egypt.—A. Gibson: Exhibition of Films showing Methods of Combating the European Corn-borer in Canada.—Capt. E. W. Shann: Exhibition of Films taken on board the *Salpa* at Plymouth.—Prof. J. P. Hill and A. Subba Rau: Exhibition of Developmental Material of the Slender Lemur (*Loris gracilis*) recently obtained from South India.—A. Subba Rau: Contributions to our Knowledge of the Structure of the Placenta of Mustelidæ, Ursidæ, and Sciuridæ.—Prof. D. M. S. Watson: The Structure of certain Palæoniscids and the Relationships of that Group with other Bony Fish.—Dr. H. H. Woollard: The Anatomy of *Tarsius spectrum*.—J. R. Baker: A Coral Reef in the New Hebrides.—J. Stephenson: Oligochæta from various Regions including those collected by the Mount Everest Expedition, 1924.—C. R. Narayana Rao and B. S. Ramanna: Note on the Conus Arteriosus of some Genera of Engystomatidæ and certain Examples of *Rana* and *Bufo* (Batrachia).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Khan Bahadur Dr. Jivanji Modi: Papur.

RÖNTGEN SOCIETY (at British Institute of Radiology), at 8.15.—Dr. R. Knox: Investigation of the Heart Movement by the Use of the Slit Diaphragm.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer Meeting at South Midland Centre.

WEDNESDAY, JUNE 10.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. E. Spencer: On some Occurrences of Spheruliticic Siderite and other Carbonates in Sediments.—L. R. Cox: Exhibition of Fossils and Lantern-slides illustrative of the Fauna of the Basal Shell-bed of the Portland Stone (Isle of Portland).

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—W. K. Alford and others: Discussion on the Application of the Supersonic Method of Reception to Ultra-short Wave-lengths.

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting at South Midland Centre).

THURSDAY, JUNE 11.

ROYAL SOCIETY, at 4.30.—Prof. W. Magnus: Animal Posture (Croonian Lecture).

LINNEAN SOCIETY OF LONDON, at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (II.).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—E. F. Fincham: The Changes in the Form of the Crystalline Lens in Accommodation.—Prof. C. V. Raman and K. Banerji: The Optical Properties of Amethyst Quartz.—The Thermal Syndicate, Ltd.: Exhibition and Description of Samples of Fused Transparent Silica, suitable for Optical and other Purposes.—Dr. R. S. Clay: Exhibition and Description of Lucernal Microscope.

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting at South Midland Centre).

FRIDAY, JUNE 12.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Brig.-Gen. Sir Percy M. Sykes: The Heart of Asia and the Roof of the World.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. G. Temple: Mass and Energy.—E. Tyler and E. G. Richardson: The Characteristic Curves of Liquid Jets.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 6.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William J. Pope: Faraday as a Chemist.

INSTITUTION OF ELECTRICAL ENGINEERS (Summer Meeting at South Midland Centre).

SATURDAY, JUNE 13.

PHYSIOLOGICAL SOCIETY (at Manchester).

FREE PUBLIC LECTURES.

MONDAY, JUNE 8.

UNIVERSITY COLLEGE, at 5.30.—Dr. J. Schmidt: The Biological Aspect of Hydrographical Work. (Succeeding Lecture on June 9.)

WEDNESDAY, JUNE 10.

UNIVERSITY COLLEGE, at 5.30.—Prof. L. J. Henderson: Blood and Circulation from the Standpoint of Physical Chemistry. (Succeeding Lectures on June 11, 12.)

THURSDAY, JUNE 11.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. J. Joly: Radiology.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.—Prof. J. Hay: Cardiology. (Succeeding Lectures on June 12, 13, 19.)

CHELSEA PHYSIC GARDEN (Chelsea Embankment, S.W.), at 5.15.—Sir A. Daniel Hall: The Sources of the Fruit and Vegetable Supply of London (Chadwick Lecture).



SATURDAY, JUNE 13, 1925.

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MACMILLAN & CO., LTD.,
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Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2902, VOL. 115]

Work and Influence of the Royal Botanic Gardens, Kew.

COAL, oil, iron and steel enter so largely into the working of the complicated civilisation of the present that it is apt to be overlooked that they are but the tools for collecting, distributing, elaborating, protecting and too often destroying the organic products on which the life of man, his culture and most of his comforts depend. Directly or indirectly, these products are the gift of the living green mantle of the earth The spread of population that has taken place concurrently with the evolution of modern industry has brought about great, and is likely to bring about still greater, changes in the earth's vegetation. Some of those transformations, such as the displacement of the native flora of prairie lands by cereals and other crops, are inevitable and, from the human point of view, beneficial; others, like the reckless destruction of forests in many parts of the world, have wasted the present and heavily mortgaged the future. The sooner the problem of ensuring a rational utilisation of the vegetation of the earth is faced in more organised fashion than at present the better

It is of peculiar importance to the British Empire, for no other power holds such vast estates, with every variety of physiographical and other conditions, and almost boundless potentialities of production. These potentialities can be developed to the best advantage only on a foundation of exact knowledge of all the conditions, and one of the most important elements of this foundation is a thorough scientific survey of the vegetation of the Empire. Although the desire for increase of knowledge of plants was stimulated by the travels and voyages of discoveries from the fifteenth century onwards, and their resulting introductions of new plants and products into Europe, a scientific survey was impossible until a rational system of nomenclature was devised by Linnæus, about the middle of the eighteenth century. Thereafter the botanical survey of the Empire began and has been in progress ever since

In British colonies and tropical possessions the benefits expected from the introduction of foreign, and the improvement of native, plants, and the need of centres where such plants could be experimentally cultivated, led to the foundation of botanic gardens in the West Indies, India, Australia, the Straits Settlements and Ceylon. These and other overseas gardens have played a very useful part in the botanical survey of the Empire, but it may be doubted if the practical importance of these institutions is appreciated as it should be, for in too many cases their history is one of cramped finances, under-staffing and scanty equipment.

Still, in founding them at all the governments concerned showed more enlightenment than was evident in the home government for many a year afterwards, for while this activity was being shown abroad the home government remained indifferent. Fortunately, this official neglect was counterbalanced by the interest in botany shared by Royal personages and men of position and wealth, and it is to such interest that the British Empire owes the foundation of the Botanic Garden that more than all the others has contributed to our knowledge of the Empire's vegetation.

The small Physic Garden, which Princess Augusta, with the advice of the Earl of Bute, formed at Kew in 1760, was greatly enlarged after her death in 1772 by her son, George III, and Joseph Banks—not long returned from his famous voyage with Cook—placed in advisory charge. For almost half a century thereafter, the king royally supported Banks in his schemes for the enrichment of the Royal Botanic Garden—as it had now become—and the botanical exploration of the lands beyond Europe. In addition to the support of the king, the interest, wealth, and influence in scientific circles of Sir Joseph Banks, the impersonal advantages of its geographical position contributed to the early pre-eminence of Kew. In tropical gardens the difficulties in controlling temperature restrict the introduction of plants to those of similar climates, while in the investigation of the vegetation of the territories they serve, most of them were and are embarrassed by a wealth of material far beyond their means to work out unaided. Here Kew was—and is—of signal service, for it could introduce plants from and to all parts, while the comparative poverty of the British flora left the Garden all the more free to extend its interests and help beyond the British Isles

Natural advantages, however, avail not without personality and means, as Kew discovered with the passing of the king and Sir Joseph Banks in 1820. For the next twenty years the Royal Gardens declined almost to extinction, from which they were rescued only by the interest of the young Queen Victoria and an agitation against their proposed abandonment that led to a committee being appointed to advise on the future of the Gardens. The committee—which included Lindley and Paxton—commented rather severely on the lack of unity of purpose and of system in the control of the overseas gardens and advocated the placing of them all under the control of a central National Botanic Garden as the best means of co-ordinating the investigation of the vegetation of the Empire and of applying such investigation to medicine, commerce, agriculture, horticulture and industry. Although the wisdom or even the feasibility of placing all the gardens of the outer lands under the official control of a central garden may be doubted, there can be no question of the advantages of co-operation and co-ordination, and there is still a vast field for cultivating both.

Although the Report of the Committee did not result in the establishment of an Imperial Botanical Survey, it brought about the transformation of Kew from a private Royal Garden into a public one, and the appointment of the elder Hooker as its first director. Since then Kew has, thanks in no small degree to the personality of its directors, proved a most valuable asset to the British Empire. On the purely scientific side, and considering only the Empire lands, Kew can point to the published floras of Australia, New Zealand, Hongkong, the Malayan Peninsula, Ceylon, India and most of its Provinces, Mauritius, the Cape, tropical Africa and the West Indies as amongst the fine fruits of its botanical leadership. On the applied side its influence on horticulture and on the introduction and cultivation of economic plants has been far-reaching and profound. Of the latter the vast growth of the rubber industry is a notable instance. It may be doubted, however, if the great practical importance to the Empire of the scientific activities of Kew and the scope for extending these are sufficiently appreciated.

Possibly one reason for this is the unobtrusive way in which the work has been carried on and the reticence practised in publishing information as to the Gardens' activities. It is, therefore, a move in the right direction that the old practice—obsolete for so many years—of publishing a review of the year's work, has been recommenced. This review, which appears under the guise of Appendix II., 1925, of the Bulletin of Miscellaneous Information, gives within 31 pages a concentrated account of the work of the Gardens during 1924. Almost every page mirrors the world-wide range of Kew, for whether it be the Gardens proper, the Museums, the Jodrell Laboratory or the Herbarium and Library, there is scarcely a land between the poles that does not give or take.

The offerings, in fact, have been for so many years in excess of the means of dealing with them that Kew has suffered from chronic indigestion. While it is good to learn that some relief has been given to this condition by a temporary addition to the Herbarium staff, it is as well to recognise that this is merely palliative. Proper treatment of the condition involves a strengthening of the whole organisation for botanical survey work—in the widest sense—throughout the Empire. The wider aspect of the problem which forced itself upon the attention of the Committee of 1838, was again examined by the Imperial Botanical Conference of 1924, whereat many excellent suggestions were advanced.

The extent to which these suggestions are likely to bear fruit will depend largely on the realisation by the home and overseas governments of the great practical importance of the Survey and on the recognition by those who have made and are making fortunes in jute, tea, cotton and other textiles, soap and such-like products, of what they owe to botanical investigations. As Dr. Burtt Davy pointed out at the Conference, the home government has good reason to give generous aid to the Survey, as England depends so much on the overseas parts of the Empire for raw products and foodstuffs. Yet the total annual expenditure on Kew is little more than equal to the interest on the proposed government guarantee for the British Empire Exhibition If England can find such a guarantee for an Exhibition so largely concerned with the organic products of the Empire, it should surely be possible to allow a more liberal endowment than is at present available for the investigation of the ultimate source of all such products. The support of the Survey should appeal no less to the overseas governments as a fruitful aid in the development of their vegetative resources and so of their populations and products. Yet at Kew, the botanical centre of the Empire, only India and the combined West African colonies are represented on the scientific staff by a single botanist each.

The fact that most of the botanical gardens of the Empire are government institutions is not an unmixed advantage, for government financial departments are apt to judge them rather too much by the irrelevant test of direct revenue and to treat them as mere luxuries to be reduced when opportunity offers, while the public scarcely thinks of them as requiring financial aid like universities, medical schools and hospitals. Governments may reasonably be expected to provide for an increase in staff and equipment and the institution—where it is not already in existence—of some system of study leave, such as the Indian scientific services enjoy, to enable members of the scientific and horticultural staffs to enlarge their experience and increase their usefulness.

But beyond such provision as any government within the Empire is likely to give, there remains abundant scope for private aid in the endowment of travelling fellowships, of exploration of the less known parts of the Empire, of lectureships on various aspects of the vegetation of the Empire, of libraries, of museums, of laboratories and of publications. For the exercise of such public-spirited liberality the Royal Botanic Gardens, Kew, which owe their enlarged foundation to the enlightened munificence of an English king, stand as a splendid stimulus and example.

Egyptian Mathematics.

The Rhind Mathematical Papyrus: British Museum 10057 and 10058. Introduction, Transcription, Translation, and Commentary by Prof. T. Eric Peet. Pp. iv + 136 + 24 plates (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 63s. net

I

PROF. PEET'S beautiful book is written for the Egyptologist and the mathematician, but not only for them. It is also for the man in the street—in such a street as runs through any university town; for the Rhind papyrus is one of the ancient monuments of learning. The famous scroll was bought in Luxor in 1858 by a Scottish lawyer and antiquary, from whose keeping it passed into that of the British Museum. There, in 1867, Lenormant examined it and referred it to the XIIth dynasty; Birch, and Brugsch the lexicographer, again examined and in part described it; and Eisenlohr (a colleague of Moritz Cantor's in Heidelberg) published a full and useful description,[1] based on facsimiles lent by the Museum—"a courtesy which he repaid by publishing a tracing of them without authority" The Museum issued an almost perfect facsimile in 1898, with an introduction by Sir E. A. W. Budge (cf. NATURE, vol 59, p. 73); and at various times the papyrus has been studied by many scholars, by Hultsch, Cantor, and Lepsius, Griffiths and Rodet, Favaro, Gino Loria and others. Prof Peet is a born Egyptologist; he has made himself a mathematician; he has "combined his information" His labours crown the exhaustive investigation of the papyrus, and he gives us its whole story in the most attractive and most readable form; he might have given us, perhaps, a fuller bibliography.

As it lies in the British Museum the papyrus is in two parts with a gap between, some one (Prof Peet does not tell us who) had the good fortune and the insight to discover that the gap was in part filled up by certain fragments in the possession of the New York Historical Society, once the property of Edwin Smith, and probably obtained by him together with a famous medical papyrus which bears his name. These New York fragments help to complete a table of fractions of which we shall speak directly, a table which is of cardinal importance for the understanding of the whole work.

The Rhind papyrus was written under a certain Hyksos king who reigned somewhere between 1788 and 1580 B.C., but the scribe states that he copied an

[1] "Ein mathematisches Handbuch der alten Ägypten," 1877.

older document of the XIIth dynasty, in a reign which can be more precisely dated as between 1849 and 1801 B.C.—some twelve or thirteen centuries before Pythagoras; this date is much the same as that of other important mathematical papyri, such as the Berlin fragment and the Moscow papyrus. Whether in its time it was a great work or a minor one, a compendium for the scholar, a manual for the clerk, or even a lesson-book for the schoolboy, we do not know; but a popular or standard work of its kind, its re-issue after more than a hundred years shows it to have been Were it only an elementary schoolbook it would still illustrate a saying of De Morgan's—we have it in the preface to his work on early "Arithmetical Books"—that "the most worthless book of a bygone age is worthy of preservation"; we may be thankful for this one, over and over again

According to our own vague impressions, we are apt to minimise or to magnify what the ancients, and not least what the Egyptians, may or must have known, we are seldom justified, we must always be cautious, in saying that the Egyptians (or the Greeks, as the case may be) did *not* know this or that. At the very least this papyrus tells us many things which they did know, and shows what were doubtless their common ordinary ways of solving their problems But mathematics is so curious a thing, the gift of numbers is so singular a mental faculty, that I should be loath to believe that there were not men in ancient Egypt who could do far more difficult calculations than any which this papyrus reveals, and do them by other methods than are set forth here.

How much earlier than this XIIth dynasty papyrus must we go to find the beginnings of Egyptian mathematics? This is one of the questions discussed, all too briefly, by Prof Peet in his fascinating introduction. Even in the first dynasty a notation was in vogue up to the sign for a million; under the IVth dynasty we find the same land-measures in use as are employed in the Rhind papyrus: the origin of learning, the beginnings of science and of the arts, recede from us the more we follow them. But so far as we can see, and so far as Plato and other Greeks have told us, the ancient science of the Egyptians ran its long course on narrow lines. There may have been dreamers among them, but (unlike Joseph) they did not tell their dreams; what we know of their wisdom the scribes have told us, and the scribes were practical men. We have no trace in Egypt of such speculative mathematics as occupied the School of Pythagoras, no discussion of first principles, no philosophy like Plato's, of which mathematics was a part. Even the Rhind papyrus is scarcely a treatise at all; it is a collection of examples, and the examples are of a strictly practical kind. For this very reason they seem strangely familiar to us; they are everyday, world-wide problems, of so many loaves to so many men and such like; they are often all but word for word the selfsame exercises which we and our children have done at school They seem to me just such simple calculations, "combining amusement with instruction," as Plato says "the sons of gentlemen should learn, as they do in Egypt."

The Egyptologist has learned much in the last few decades, and the mere translation of the text is far more certain in Prof Peet's hands than in those of its first students There is a curious instance of the early difficulties of the translator—Prof. Peet only half relates or merely hints at it The text of a certain problem, all but the last in the book, led Eisenlohr to assert that the powers of a number had specific and curious Egyptian names—the scribe, the cat, the mouse, etc. Favaro, for one, was suspicious; he called this "una denominazione così strana da far dubitare che l' Eisenlohr abbia rettamente interpretato a questo punto il papiro"; and Cantor said he could neither verify nor disprove the statement. Léon Rodet, reading the *Liber Abaci* of Leonardo Pisano (or Fibonacci, as we usually call him), was struck by the resemblance of the series to a problem there: Septem vetulae vadunt Romam; quaelibet habet burdones (i.e. *donkeys*) septem, etc. Why, it is just the medieval setting of our own immortal "As I was going to St. Ives"; and so they had it in Egypt also: "[In such a town] were seven scribes[2]; each scribe had seven cats, each cat caught seven mice"; and so on.

The Egyptian notation was a decimal one, as was that of all ancient peoples save the older Babylonians, but the Egyptians had signs only for the unit, for 10, 100, and so on up to 100,000, each of these signs being repeated the required number of times; it follows from this that addition, or "putting on," and subtraction or "breaking off," were merely mechanical processes. Multiplication and division were performed under strict limitations. To multiply by 10 was easy, for it only meant turning the unit-symbols into 10's, and so on; yet this easy method was not always employed. With very few exceptions the Egyptian multiplied by two, and by no other number: his multiplication table, the multiples which he knew by heart, would seem to have stopped at two-times. He employed the processes of *duplication* and *dimidiation*, rather than of multiplication and division; and books of arithmetic maintained the same distinction at least up to the sixteenth century. He kept on doubling; and he could

[2] Prof. Peet now translates "seven houses."

then pick out, or tick off, from the successive products any multiple he pleased. Thus to multiply 7×11, he would write down

/ 1	7
/ 2	14
4	28
/ 8	56
11	77

He added together the once, twice, and eight times: we add together the once and the ten times; that is wellnigh all the difference. Moreover, when we do our sums by "practice," we are using a very ancient method and doing them almost exactly as the Egyptians did.

Why, when he started with a symbol for 11, consisting of a unit and a ten, he did not at once write down seven units and seven 10's, and so obtain his symbol for 77, we do not know—and we are left wondering; but the method here exemplified is the one which runs all through the book. It seems impossible to believe that the old mathematician was really limited to this cumbrous method; and it is tempting, therefore, to suppose that he inculcated it for a deeper reason. Rodet believes that his purpose was to demonstrate a theory of proportion, to show that two quantities retain the same relation to one another, whatever identical operations of multiplication and division they have both undergone.

The above method of multiplication could not go far, and the converse process of division could not be effected at all, without constant use of fractions; and these the Egyptian handled with extraordinary skill, though again his limitations were severe. While he could easily express any whole number, he had no notation for fractions (with the single exception of $\frac{2}{3}$) other than as aliquot parts, *i.e.* as fractions the numerator of which is unity—fundamental fractions, as Schiaparelli called them; all other fractions had first of all to be reduced to these, and how to do so, how to reduce any fraction to a series where each has unity for its numerator, is a problem which has not yet ceased to interest mathematicians. The Greeks (with certain exceptions) did precisely the same thing; thus Archimedes writes $\frac{1}{2}$, $\frac{1}{4}$, for $\frac{3}{4}$, and Hero writes $\frac{1}{2}$, $\frac{1}{17}$, $\frac{1}{34}$, $\frac{1}{51}$ when he wants to express $\frac{3}{51}$; moreover, the Greeks had special signs for $\frac{1}{2}$ and $\frac{2}{3}$, but for no other fractions.

The Egyptian kept by him a table of these equivalent fractions, which table, as Cantor says, we can only suppose to have grown slowly into shape as the result of protracted labours. How it was achieved at all is a question elaborately discussed by Cantor, Eisenlohr, Hultsch, Griffiths, and others, and now by Prof. Peet; but there seems to be no clear and certain answer yet, and Cantor confesses openly to failure. The Rhind papyrus carries the list from $\frac{2}{5}$, $\frac{2}{7}$, etc., as far as $\frac{2}{101}$. $\frac{2}{5}$ was easily resolved into $\frac{1}{3}+\frac{1}{15}$; $\frac{2}{7}$ into $\frac{1}{4}+\frac{1}{28}$, etc, but some of the resolutions were of necessity complicated, *e.g.* $\frac{2}{61}=\frac{1}{40}+\frac{1}{244}+\frac{1}{488}+\frac{1}{610}$; or $\frac{2}{89}=\frac{1}{60}+\frac{1}{356}+\frac{1}{534}+\frac{1}{890}$. The papyrus explains them all, one by one, for example:—

Divide 2 by 13

$1\frac{1}{2}+\frac{1}{8}$ is $\frac{1}{8}$ $\frac{1}{4}$ is $\frac{1}{52}$ $\frac{1}{8}$ is $\frac{1}{104}$

Working out

	1	13
	$\frac{1}{2}$	$6\frac{1}{2}$
	$\frac{1}{4}$	$3\frac{1}{4}$
/	$\frac{1}{8}$	$1\frac{1}{2}+\frac{1}{8}$ /
/	$\frac{1}{52}$	$\frac{1}{4}$ /
/	$\frac{1}{104}$	$\frac{1}{8}$ /.

13 has been split up into parts, first by successive divisions by 2, afterwards by the scarcely more difficult operation of taking $\frac{1}{13}=1$, and therefore $\frac{1}{52}=\frac{1}{4}$. The next step is tacitly assumed: namely, to pick out from the divisional parts of 13 such as, taken together, amount to 2; and the corresponding fractions of 1, standing opposite to them, are the series required.

It may well be that what is here set forth does not purport to be an explanation of the method, but merely a proof or verification of the result stated; so also in many other problems with which the papyrus deals—the answer is given, and the working shown is that required to check or confirm it. Prof. Peet, however, thinks that the setting out of the proof gives us a clue to the way in which the result was actually obtained; the method was clearly one of trial and error. The Egyptian "had grasped the fact that the problem consisted in breaking up 2 into the sum of several quantities, each of which would divide without remainder into the given denominator"; and accordingly, Prof. Peet shows us, alongside of the resolved fractions, the corresponding resolutions of 2—as being the first step towards the discovery of the former.

We, I imagine, would proceed otherwise. We should probably begin by multiplying the numerator and denominator of our fraction $\frac{2}{n}$ by some number, greater than $\frac{n}{2}$, until we found the new numerator resolvable into parts, each a convenient sub-multiple of the new denominator. Thus $\frac{2}{13}=\frac{2\times7}{13\times7}=\frac{13+1}{13\times7}=\frac{1}{7}+\frac{1}{91}$; and this seems a simpler result than that arrived at by the Egyptian; it seems to prove that this was not the Egyptian's way. It is curious that this is the very

result we get by the method shown in the late Greek papyrus of Akhmim.[3]

But the more we look at the Egyptian's table of resolutions the more satisfactory and even elegant does it appear; it is only very seldom that we can suggest a better alternative. There is no simpler resolution, for example, of $\frac{2}{97}$ than $\frac{1}{56}+\frac{1}{679}+\frac{1}{776}$, which is what the table gives. For $\frac{2}{35}$ we might prefer $\frac{1}{30}+\frac{1}{210}$ to $\frac{1}{30}+\frac{1}{42}$, which latter is what the Egyptian gives; but he is probably right in avoiding the higher denominator. In this case he has resolved 2 into $\frac{7}{6}+\frac{5}{6}$, or, as he writes it, $1\frac{1}{6}\ \frac{1}{2}+\frac{1}{3}$: he adds a note to show that he realised he was dealing with $7\times\frac{1}{6}$, and $5\times\frac{1}{6}$. It is one of the cases which seem to show that he was not hampered by lack of skill, so much as by his strictly limited and conventional notation.

The last case of all, namely, $\frac{2}{101}$, is an interesting one, the solution given is $\frac{1}{101}+\frac{1}{202}+\frac{1}{303}+\frac{1}{606}$, a form of resolution differing from any other in the long list, for here, and here alone, one of the fractions is just one half of, and thus has the same denominator as, the fraction to be resolved. Prof. Peet remarks that "mathematically the result is surprising and disappointing; it may be surmised from this feeble ending that the mathematician was here at the extreme range of his ability." I do not think so; the solution seems to me an elegant one, and what is more, *there is no other* which does not involve very high denominators; the simplest, and much the simplest alternative which I can discover, is $\frac{1}{606}+\frac{1}{4\,04}+\frac{1}{1\,515}$, but this last denominator is much higher than any other which the table admits or contains.

From the Table of Resolutions of $2/(2n+1)$, we pass to problems where so many loaves have to be divided among ten men, the rule as to aliquot parts is still adhered to, and the problems are little more than simple exercises on the preceding table. From these we go on to somewhat more difficult but closely related exercises, involving the addition and subtraction of fractions; these are what are called the *skm*, or *sekhem*, problems, *i.e* problems of *completion*. "Democritus spent a quarter of his life as a boy, a third as a youth, a fifth in manhood, and he has been an old man for thirteen years; how old is Democritus?" This is a well-known problem in the Greek Anthology; I take it to be a typical *sekhem* problem. Those which our papyrus gives are in plainer form. For example, given the series $\frac{1}{4}+\frac{1}{8}+\frac{1}{10}+\frac{1}{30}+\frac{1}{45}$, we are asked to complete it to $\frac{2}{3}$, in other words, to subtract it from this latter fraction. Most of the working is omitted. The fractions are first replaced by the numbers $11\frac{1}{4}\cdot 5\frac{1}{2}+\frac{1}{8}\ \ 4\frac{1}{2}\cdot 1\frac{1}{2}\cdot 1$, which are numerators corresponding to a common denominator 45. The complete series is then stated as follows:

$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{10}$	$\frac{1}{30}$	$\frac{1}{30}$	$\frac{1}{30}$	$\frac{1}{45}$	$\frac{1}{3}$
$11\frac{1}{4}$	$5\frac{1}{2}+\frac{1}{8}$	5	$4\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{8}$	1	15

"making 1,"

and $\frac{1}{10}+\frac{1}{40}$ is seen to be the required "completion" of the original series to the sum of $\frac{2}{3}$. The phrase "common denominator" is, of course, modern, for the Egyptian has no equivalent word; nor indeed was it precisely a "common denominator" which he sought and used. In the above example the common denominator would be 360, the Egyptian was content with the denominator 45, for, though the corresponding numerators were often fractional, they were simple fractions such as gave him no trouble to employ.

Rodet has emphasised more than Prof. Peet the distinction between this operation and ours; and he has shown in a very interesting way how what was precisely the old Egyptian method survived in Jewish and Moorish arithmetic. The Hebrew *môré*, the "ruler" or "guide," and the Arabic *mokhraj*, or "block"—out of which what we require may be hewn—had a wider meaning than our "common denominator", it was anything to parts of which our fractions may be considered equivalent—even the fraction $\frac{1}{2}$ was looked upon as having 2 for its *mokhraj*. We do the same thing, though we forget we do so, every time we write or think of $\frac{1}{2}$—which, by the way, is a very different concept from 0·5. When we speak of $\frac{1}{2}$, we mean that something, that "fraction," which has the same relation to 1 that 1 has to [our *mokhraj*] 2. As Rodet puts it, "il est bien certain qu'Aahmesu ne 'réduisit ses fractions à un dénominateur commun,' mais que, comme on l'a fait après lui pendant vingt-six et trente siècles encore, il choisissait un nombre, bloc extractif, fonds commun ou comme on voudra l'appeler, d'où il puisse tirer toutes ces fractions, soit comme ses successeurs à l'état d'entiers, soit comme il s'en contentait à l'état d'*à peu près entiers*, mais, dans ce cas, avec une fraction d'expression simple; et c'est sur les substituts ainsi obtenus pour ses fractions qu'il opérait." If our method has any advantage it is merely one of arithmetical technique; the older arithmetician saw as deep, if not deeper, into the heart of the problem.

It seems to me that we may help ourselves to understand the Egyptian way of dealing with fractions if we take a hint from Herodotus, and remember that the Egyptian did his counting with *pebbles*. I can imagine him pondering over a handful of pebbles, and trying to divide it into aliquot parts; then, if necessary, taking more and more similar handfuls, until he got at last a suitable and satisfactory *mokhraj*.

D'ARCY W. THOMPSON.

(To be continued.)

[3] Cf Heath's "A History of Greek Mathematics," vol. 2, p. 543.

Nature and Mind.

(1) *Prolegomena to an Idealist Theory of Knowledge.* By Prof. Norman Kemp Smith. Pp xiii + 240. (London: Macmillan and Co., Ltd, 1924.) 10*s* 6*d* net

(2) *Modern Theories of the Unconscious* By Dr. W L Northridge. Pp. xv + 194. (London Kegan Paul and Co., Ltd., 1924) 8*s*. 6*d*. net.

(3) *The Nature of Laughter* By J C Gregory (International Library of Psychology, Philosophy and Scientific Method.) Pp. v + 241. (London: Kegan Paul and Co, Ltd; New York Harcourt, Brace and Co., Inc, 1924.) 10*s*. 6*d*. net.

(4) *The Beautiful.* By Henry Rutgers Marshall Pp x + 328. (London: Macmillan and Co., Ltd, 1924) 15*s*. net.

(5) *The Philosophy of Music.* By Dr. William Pole. Sixth edition, with an Introduction by Edward J. Dent, and a Supplementary Essay by Dr Hamilton Hartridge. (International Library of Psychology, Philosophy and Scientific Method.) Pp xxiv + 342. (London. Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 10*s*. 6*d*. net.

THE common presumption of the mutual indifference of philosophy and science has never been true of the masters Every great creative mind in philosophy has been responsive to the scientific situation and method of his day, and most of those who have formulated the decisive hypotheses of the various sciences have recognised the scientific importance of those inquiries into the presuppositions of knowledge or into the most general features of reality, which are the proper business of philosophy. But though the greater movements of both disciplines have thus influenced each other, it is no doubt true—and part of the price we pay for our instrument of specialised investigation—that the detailed working out of these dominant conceptions in each field has proceeded with relatively little reference to the other; and that from time to time there has been evident a failure of adjustment and harmony.

One of the significant elements in our contemporary position is that both sides seem to be increasingly conscious of the loss involved in such a failure, so that there is a well-marked effort to co-ordinate the results of both lines of inquiry. Of this tendency, so far as it touches philosophy, Prof. Kemp Smith's important essay in the theory of knowledge (1) is the latest and a most instructive example: and although it is a technical and even a difficult book, it may well be recommended to the attention of those who wish to see how philosophical discussion is affected by and shapes towards current scientific thought. Prof. Kemp Smith's problem, of course, is primarily philosophical, and its orientation to scientific interests is incidental. He is concerned with the relation of the long-continuing idealist tradition to the resurgent and perhaps now dominant mode of philosophical realism. But this realism is itself a product of the impact of science on philosophy, or (more accurately) it represents in philosophy, now as always, the preoccupation with the distinctively scientific problem and point of view. In dealing with it Prof Kemp Smith avails himself, though as buttresses rather than as foundations of his conclusions, both of Dr. Whitehead's philosophy of Nature, and of the physiological researches of Dr. Head and Sir C. S. Sherrington, while one important section of his argument is governed by certain general biological considerations

The title of the book is elliptical. It offers not what would ordinarily be called an idealist theory of knowledge, but a theory of knowledge thoroughly realist in temper as a prolegomenon to an idealist metaphysic. Of this latter, nothing is here given except brief indications at the beginning and end of the book. But these are sufficient to show the relation which the writer intends his theory to bear to idealist doctrine What he aims at doing is, in a word, to reform and strengthen its main defences which (he thinks) have been badly shattered by realist criticism.

The crucial issue for idealism, Prof Kemp Smith holds, is as to the status in reality of the great human interests of knowledge, morality, art and religion Now idealism has been wont to rest the defence of these interests upon a particular view of the relation of subject and object in knowledge, which it has reached by an analysis of the implications of the intelligibility of the world. It has supposed that such an analysis would show that the world of our experience depends for certain of its ultimate features on the constitutive character of its relation to mind: and that if reality thus accepts the lead of mind in the process of knowledge, the way is open to us to hold that it will do so also in the further constructions which mind puts upon it.

Prof. Kemp Smith does not wholly dissent from this approach. It is essential to his view to hold to the correlation of mind and Nature, in virtue of which the categories or *a priori* principles of explanation employed by the mind are interpretations of the real world. He holds, too, that it is by these categories that we are led to the further ideal determinations of our higher spiritual interests. But he clearly believes that much of the familiar statement of this argument is vitiated by an assumption that this correlation implies that mind somehow dictates to Nature, so that the idealist version of the *a priori* is entangled in the embarrassment of subjectivism. Against all theories of this sort he

accepts as valid the realist principle that if knowledge is to be genuine, it must be knowledge of an independent reality, which the mind in knowing neither makes nor alters. His agreement with that view is expressed in a full critical statement first of the attractiveness and then of the defect of the whole doctrine of "representative perception."

Prof. Kemp Smith seeks, therefore, to free idealism from this subjectivist implication. The escape lies in taking Nature as an authentically independent system; and from that viewpoint finding a new and thoroughly objective deduction of the categories. If Nature is such a system, space and time, its fundamental features, must be independently real, and it is as such, Prof. Kemp Smith holds, that they do, in fact, disclose themselves to the mind. They are not forms imposed by the mind, nor are they constructions or elaborations of sense data of another sort. But they reveal themselves not indeed through but in terms of sense experiences or "sensa" of various kinds · and the apparent dependence of these sensa (as in the secondary qualities) on different apprehending minds raises a question of their objective character Prof. Kemp Smith's solution is that the sensa though "private," *i.e.* occurring in connexion with particular physical and physiological conditions at particular points in space and time, are not "subjective" but are capable of statement as events in an objective order, so that their interpretation as such may be taken to yield knowledge of that order. Finally the categories, through the fundamental categories of totality and necessitation, are involved in our intuition of space and time. They, too, therefore, are directly apprehended as constituent of Nature. In themselves they are formal and problematic, predetermining nothing, but dependent for their concrete significance on our experience of the objective order

Here, then, so to say, the defences of idealism are reversed If the metaphor of prescription is in order at all, it is Nature which prescribes to mind, not mind to Nature. But whatever the priority, at least mind remains integral to Nature and our dealings with reality are face to face. What measure of idealism may rightly be based upon a so little pretentious theory of mind is not yet declared. It is possible that Prof. Kemp Smith has conceded to the realist criticism more than is strictly compatible with an idealist view: but at all events a highly interesting and even exciting sequel is promised.

The tendency exhibited in Prof. Kemp Smith's book to "democratise" the mind, as Prof Alexander calls it, to put the mind in its proper place in relation to the rest of the natural order, has been operative in other regions than those of epistemology and metaphysics. The modern analytic movement in psychology associated with the name of Freud has been working to the same end. Its purpose is to interpret mind by its own natural history, and to show its dependence upon energies and functions which, if not simply bodily, are at least closely connected with the body.

The main tenet of the recent teaching on this topic centres on the larger meaning and greater significance attached to the conception of the unconscious. Dr. Northridge in his book (2) rightly singles out as the cardinal point in Freud's theory the distinction between the "preconscious" and the "unconscious." The older view of the unconscious regarded it as covering only those states of mind which were temporarily out of the field of consciousness, but could be revived, sometimes not without difficulty, but without special artificial preparation. This Freud designates the preconscious, reserving the name unconscious for those states which, because of their incompatibility with conscious interests, can enter consciousness only in a disguised and symbolical form, but which, though thus largely excluded or repressed, profoundly affect the tenor and quality of conscious life. Dr. Northridge explains the genesis of this conception through a discussion of Hartmann, Schopenhauer, Myers's theory (or theories) of the subliminal self, and those more recent students of the phenomena of dissociation and multiple personality like Janet, Sidis and Morton Prince. Chiefly, of course, he is concerned with Freud, and with the evidence on which Freud bases his revolutionary theory. With Freud's work, Dr. Northridge compares that of Jung and the late Dr. Rivers; and indicates the points on which he regards their later and broader treatment as more satisfactory. Dr. Northridge's book is almost wholly expository; he clearly takes Freud's work to be decisive on the general question as to the validity and fruitfulness of the analytical method. But within the limits which he sets himself it is a careful, competent and discriminating survey of the field, with its emphasis and contrasts well taken and justly marked.

On Freud's view, one of the main supports for the hypothesis of the unconscious is furnished by the study of wit Mr. Gregory's learned discourse on laughter (3), however, is not unduly oppressed by Freudian theory. Freud, like Bergson, he believes to have thrown light on certain forms of laughter; but neither theory is universally applicable. Mr. Gregory works on a larger canvas. He ranges the whole field of recorded human laughter, from Homer to Charles Chaplin; and though the central idea which he derives from his survey is not novel, he illumines it with many fresh and suggestive analyses. His method is cautiously empirical. Laughter is endlessly varied in its occasions, forms and associated emotions. Still, if we follow the clue given

by the physical process of laughter, it is possible to recognise in all forms of it one fundamental mechanical pattern, which may be described by the word "relief." Laughter occurs whenever an agent having prepared himself for action of some kind finds that action is unnecessary; it is the bodily concomitant of release from some position of tension The variety of the forms of laughter is traceable to the very different ways in which this experience of relief can occur, from simple physical sensations like tickling to the most complex psychical situations. But certain main types of laughter can be distinguished; and, Mr. Gregory holds, it is possible to show how these types emerge and change with the progress of civilisation. The first type is ungracious laughter, laughter touched with contempt or animus, as against physical deformity or over a beaten enemy. But its later forms are more refined and kindly--as in the genial laughter of sympathy which is the source of humour, or in that distinctively intellectual form of it which is expressed in the comic spirit

Mr. Marshall's treatise on æsthetics (4) takes the reader into a wholly different atmosphere. It is, in its way, an old-fashioned book, not over much concerned (except for Croce) with the most modern theories, but building a lucid and persuasive if not wholly convincing argument with a delicate and careful craftsmanship that is worthy of its theme. Mr Marshall seeks first to develop his theory and definition of the beautiful The conditions of beauty, he holds, cannot be stated in purely objective terms. An object, of course, is necessary, to provide the external stimulus; but since very different æsthetic judgments are passed on the same objective factors, there is clearly involved a subjective element as well. Where then is beauty to be found?—in sensation, or in perception or in the intellectual apprehension of certain formal relations subsisting between the parts of a perceived object? Or is its source rather in imagination or in emotion or in feeling, or perhaps even in religious and moral ideas? Each of these views, Mr. Marshall holds, might suffice to define some of our experiences of beauty, but none of them applies to all. Mr. Marshall's own account is that beauty is "relatively stable or real pleasure." "We call an object beautiful which seems always to yield pleasure in impression or contemplative revival." Similarly, ugliness is relatively stable disagreeableness.

One may perhaps suspect that if preceding theories have erred by defect, Mr. Marshall's zeal for an all-inclusive account leads him to err by excess. No doubt all experiences of beauty yield pleasure of the kind here described. But it does not appear that, as the theory requires, this proposition is convertible simply. There seem to be fields of relatively stable pleasures to which the term beauty cannot be strictly applied The enjoyment of a strenuous game may be more stable, both in act and in recollection, than that of the loveliness of a fleeting sunset; but it is not therefore more beautiful, or even beautiful at all. Mr. Marshall is not unmindful of this difficulty. But his escape from it, mainly by an appeal to the revivals of meaning associated with particular pleasure experiences, scarcely goes to the heart of the matter.

The remainder of the book gives the application of the theory to some of the major questions of æsthetic philosophy; and a short historical review of the relation of various æsthetic theories to the metaphysical systems in connexion with which they have been developed

"The Philosophy of Music" (5) is the sixth edition of a well-known book by Dr. William Pole It is introduced and supplemented by short essays from Mr. E J Dent and Dr. Hamilton Hartridge. The book gives no hint to this later generation of the rather unusual combination of interests in its author, though the reader might guess from the treatment that Pole was much concerned with physics and structures. If further issues are called for, a biographical note would not be out of place H. J W HETHERINGTON.

The Energetics of the Living Cell.

Chemical Dynamics of Life Phænomena By Prof Otto Meyerhof (Monographs on Experimental Biology) Pp 110 (Philadelphia and London: J B Lippincott Co., 1924.) 12*s.* 6*d* net.

THE scope of this fascinating addition to the series of American Monographs on Experimental Biology is restricted to the two fundamental and interconnected problems of cell respiration and the energetics of cell processes The book is founded upon a series of lectures delivered in Cambridge and New York in 1922–23 and presents a connected account of the author's well-known work, considered in close connexion with that of other investigators, both in Germany and elsewhere.

These researches have revealed another example of the extraordinary complexity of the physical and chemical mechanism which has been evolved for the realisation of a fundamental physiological requirement, in this case the provision by the organism of energy available for the performance of work, either chemical or mechanical. Two methods for the accomplishment of this are found to exist, both subject, as are all processes in the living organism, to the limiting condition of a low and often an almost constant temperature. These are the aerobic system, in which the energy is derived from the oxidation of food materials, and the

anaerobic, in which it comes from their fermentation. The comparative study of these two processes—respiration and fermentation—forms the subject of one of the most interesting chapters of the book, to which the previous sections on the mechanism of cell respiration and autoxidations in the cell serve as an introduction.

The author traces in detail the intimate relations which have been established between these two apparently independent but in reality closely allied processes, and concludes on a justifiably triumphant note: "It may indeed be considered a success of general physiology and its mode of experimenting, that the chemical dynamics of a highly differentiated organ like the muscle could be partly revealed by the study of the alcoholic fermentation of yeast."

The ensuing chapter, on the transformation of energy in muscle, carries the tale a stage further, and shows how far the tangled skein of physical and chemical changes involved in the contraction and relaxation of muscle has been unravelled. To appreciate the boldness of idea and skill in technique which have gone to the solution of this problem, this work must be studied in detail. To summarise very briefly and imperfectly, it may be said that during the contraction of a muscle, glycogen is rapidly converted into lactic acid, energy being thus rendered available by the chemical change and by the reaction of the resulting lactic acid with the alkali protein of the cell, too great a change of hydrogen ion concentration being at the same time avoided. So far the change is anaerobic and independent of the presence of oxygen. Relaxation is accompanied by the absorption of oxygen and the complete oxidation of a varying fraction, a quarter to a sixth, of the lactic acid, the remainder of the lactic acid being at the same time reconstituted into glycogen and the alkali protein of the cell restored to its original condition. Truly a remarkable device.

The concluding chapter is more general and speculative in its character, and deals with the difficult question of the constant exchange of energy which goes on in cells which perform no external work. No complete answer to this question has been obtained, but its investigation, particularly with respect to the metabolism of bacteria and algæ, has led to many important results which are here chronicled. One interesting point alone can be picked out for reference. The author has shown by direct experiment—poisoning a mass of respiring avian blood corpuscles in a calorimeter—that the old idea that living protoplasm has a higher energy content than dead is incorrect. No evolution of energy occurs at the moment of death, and the mysterious difference between living and dead matter cannot be explained on energetic grounds.

This short work must be regarded as a true romance of science, and to the sufficiently prepared reader its pages present a theme of the most enthralling interest. A pleasant feature of the book is the ungrudging recognition of the contributions of other workers to a subject which has aroused widespread interest and has been approached from many different directions.

ARTHUR HARDEN.

Our Bookshelf.

The Nature of Life. By Prof. W. J. V. Osterhout. (Brown University: The Colver Lectures, 1922.) Pp. vii+117. (New York: Henry Holt and Co., 1924.) 1.50 dollars.

A most pleasantly written book that discusses such questions as the origin, criteria and control of life in a manner making the story of what the biologist has done and is doing in that particular field readily intelligible to the educated lay reader. The United States is to be envied in having endowments permitting public lectures of this quality to be published in book form.

The question of the origin of life is discussed and, as is inevitable just yet, is not answered. This is followed by a discussion as to the criteria by which the living is to be distinguished from the dead. Growth is not a criterion, for there can be life without growth and growth without life. There can be life without reproduction, in individual cells, such as nerve cells, or organisms, such as the resting seed, there is no reproduction, no suggestion of cell-division, yet life may go on for many years. Motion is not one of the essential characteristics of living matter. There is no logical necessity for regarding the simplest cases of irritability as essentially different from certain reactions found in non-living systems. Constructive metabolism may cease, yet life may go on for many years, but the cessation of destructive metabolism marks the end of life. In the case of the resting seed, so long as it is alive it produces carbon-dioxide: when this ceases it is dead. Life as manifested in the simplest organisms is a physico-chemical process in which destructive metabolism plays a fundamental rôle. As soon as a cell dies its power of selective absorption ceases. Certain dyes will not enter a living cell; others will do so and become stored within, reaching a higher concentration than outside. The process obeys a definite mathematical law. This storage does not occur in dead cells to so great an extent. Another method is to send an electric current through the cell; by measuring the amount of the current the progress of death can be followed with the same exactitude as that of a chemical reaction. Death is an orderly process following a definite law that can be expressed mathematically. In order to control life it is first necessary to control mutation, and before this can be done the physico-chemical factors on which mutant characters are based must be completely analysed. With the control of mutation will come the power to create new species.

The Internal Secretions: for the use of Students and Physicians. By Prof. Dr. Arthur Weil. Authorised translation of the third German edition by Dr. Jacob Gutman. Pp. xviii+287. (London: G. Allen and Unwin, Ltd., 1924) 18*s.* net.

THE author's method of presentation of his subject is one much to be recommended. Instead of dealing with each endocrine organ separately, he has chosen as subjects all the main physiological functions and describes the way in which each function is controlled by the endocrine glands operating either singly or in co-ordination.

Medical students and practitioners, for whom the book is intended, will certainly find in it much of interest and of value. Internal secretion is defined, the embryology and histology of the endocrine glands discussed, and there follow chapters on the physiology of the blood, circulation, respiration, metabolism, growth, reproduction, the sexual impulse, the mind, the chemistry of the endocrines, methods of testing for internal secretions; the inter-relationship of the endocrine glands; internal secretion and the nervous system. There is no bibliography, but the reader is referred to works of Biedl, Lipschütz, and others.

We agree with the translator that this book will be useful to students and general practitioners, and that medical specialists in other subjects will find in it sections dealing with the relation of endocrinology and their own special branches. This comprehensive elementary treatment is well suited to beginners, notwithstanding the fact that it contains within a small compass an immense amount of information. The book was not written for the endocrinologist, but by an endocrinologist for the German medical profession, and that which may be incomplete for the specialist may be more than enough for the general practitioner.

An Introduction to the Study of Southwestern Archæology: with a Preliminary Account of the Excavations at Pecos. By A. V. Kidder. (Published for the Department of Archæology, Phillips Academy, Andover, Massachusetts.) Pp. vii+151+50 plates. (New Haven: Yale University Press; London: Oxford University Press, 1924) 20*s.* net.

FOR some years past American archæologists have devoted great attention to the south-western States, particularly New Mexico, and at the present moment excavations are being carried out on several sites. Of these Pecos in San Miguel County, New Mexico, is one of the most important, not only on account of its size, but also because of the length of time over which it was occupied by the Indian. There is a recorded occupation of practically three centuries, from 1540 until 1838, when it was abandoned, while the abundance of pottery of archaic type scattered among the mounds shows that it had been occupied for a long period before the coming of the Spaniards in the former year.

Although the account given in the second section of this volume is only a preliminary report dealing with the work in 1915 and 1916 and from 1920 onward, and it will be many years before the work is complete, it is already abundantly clear that the site is one of great importance and will without doubt throw much light upon the history and relative chronology of the development of culture in the south-western area. In the remaining three sections of the book, Mr. Kidder deals respectively with the history of Pecos, the results obtained from excavation of the other sites of the south-west which have been explored, and in conclusion summarises these results in a general sketch of the rise and development of south-western culture. As a whole the book is a valuable contribution to the study of American archæology which will prove of great assistance to those who wish to understand the general trend of current research in this part of the States.

Handbook to the Technical and Art Schools and Colleges of the United Kingdom. Compiled from Official Information. With an Index to Courses of Instruction. Second edition, revised and enlarged. Pp. iv+170. (London: Scott, Greenwood and Son, 1925) 6*s.* net.

As a reference book to the technical schools and colleges of the British Isles, the volume before us will no doubt serve a useful purpose. It is divided into five sections, dealing respectively with London, England (provinces), Scotland, Wales, and Ireland, the last section being subdivided into two sections covering Northern Ireland and the Irish Free State. In the London group the schools are arranged alphabetically, whereas in the remaining sections they are under towns, which again appear in alphabetical order. Under each entry is given essential information about the school, together with an indication of the courses of study, day and evening, which are available. There is a full index to the courses of instruction, so that it is possible to see quickly where any particular subject is studied.

Stories of the Birds from Myth and Fable. By M. C. Carey. Pp. 192+8 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924) 5*s.* net.

THE author of this book has culled from many standard works on the folklore of peoples such myths, legends and fairy tales as relate to birds, and has recast them in simple language suitable for children. The result is a series of quite charming tales, delightfully told, which, in the pleasant guise of fable, include a considerable measure of true and salient facts about the form, habits and natural history of birds. Primitive man was always a close observer of natural things, and the myths which centre round natural phenomena are merely his attempts to find reasons for things which he could not otherwise explain.

Children will be delighted with this book. Those who are students of birds will be no less interested in the ingenious and fanciful explanation of avian habits and structure put forward by early man.

Skill in Work and Play. By Prof. T. H. Pear. Pp. 107. (London: Methuen and Co., Ltd., 1924) 4*s.* net.

THIS book is a study of the way in which muscular skill is acquired. It is eminently popular in exposition; but behind its somewhat racy style lies the weight of facts that have been investigated in carefully planned research. Prof. Pear applies the facts, originally brought to light in connexion with problems of industrial psychology, not only to the acquisition of dexterity in such operations as typewriting and metal polishing, but also to those of athletic skill as exemplified in cricket, skating, and similar games and sports.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Taungs Skull.

I OWE to the kindness of my friend Dr Broom a preliminary sketch of a sagittal section through this remarkable skull. Prof. Dart, though he is himself earnestly engaged in the description of the skull, has generously afforded Dr Broom full access to it with permission to publish any observations he may make.

As the preliminary section is extremely interesting and completely confirms, so far as it goes, the statements of Prof. Dart, I have been tempted to compare it with similar sections through the skulls of young chimpanzees preserved in our University Museum, which my friend Prof. Goodrich has kindly put at my disposition.

In Fig. 1 the profile of the Taungs skull (continuous

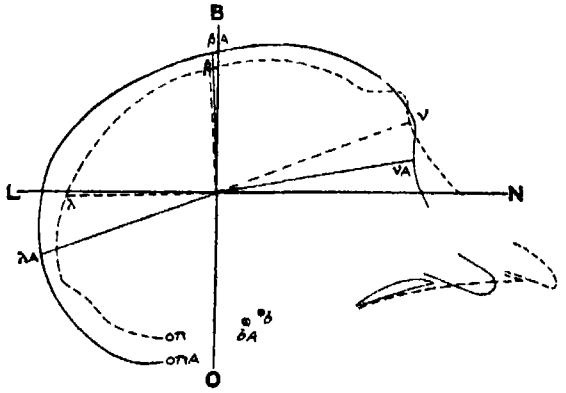


FIG. 1.—Superposed profiles of Taungs skull (continuous lines) and of skull of young chimpanzee, one true molar erupted (broken lines). *OB*, occipito-bregmatic axis; *LN*, lambda-nasion axis; *n*, nasion; *β*, bregma; *λ*, lambda. Points on the Australopithecus profile are distinguished by the addition of the letter *A*. (× about ½; the greatest length of the Taungs skull is 127 mm.)

lines) and that of a young chimpanzee (broken lines) are superposed on a common morphological centre and the bregma-occipital axis. The greater size of the Taungs skull is sufficiently obvious, and equally so the complete absence of a frontal torus, while this feature is already well developed in the chimpanzee. The bregmas are nearly coincident but the lambdas are far apart, and the parietal arc of the Taungs skull (108°) is therefore considerably larger (19°) than that of the chimpanzee (89°). This marks an approach towards the human side. The comparative shortness of the face and the diminished prognathism of the Taungs skull are also well displayed.

I ought to mention that the basion and opisthion are not preserved in the Taungs skull, but their probable position has been indicated by Dr Broom with a possible error of 2 mm. for the opisthion and 4 mm. for the basion.

In Fig. 2 the profile of the Taungs skull is compared with that of a chimpanzee already furnished with a complete dentition. It will be seen that the Taungs skull, although in an earlier stage of development, has attained to a profile of about the same area as that of the adult chimpanzee, which in this specimen has a cranial capacity of 440 c.c.

In Fig. 3 full sagittal sections are given in place of profiles, and that of the chimpanzee has not been obtained from the one shown in Fig. 2 but from another adult specimen. No stress can be laid on the comparison of the two sections, since they represent different stages of growth. In a young chim-

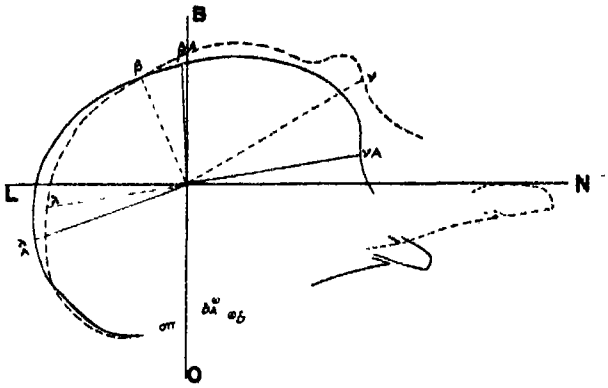


FIG. 2.—Profiles of adult chimpanzee and Taungs skulls superposed. (× about ½.)

panzee, with only the first molar erupted, the anterior extremity of the brain may extend much farther downwards than in the adult.

Attention, however, may be directed to a peculiarly interesting feature of the Taungs skull as displayed in this figure. It will be seen that the nasion is situated, as in man, close to the anterior limit of the brain. In the higher apes this relation is lost at an early stage; the nasion rises progressively with age, and so does the frontal bone, which seems to turn upon the bregma as upon a hinge. This is well illustrated by the profiles of chimpanzees in different stages of growth shown in Fig. 4.

I should have liked to make a comparison with the skulls of young gorillas, but unfortunately our collection does not contain any skulls in which the first true molar has alone been cut. We have adult skulls and some with the deciduous dentition only. Of the latter there is, however, one in which the first molar, though still occluded, is not far from eruption,

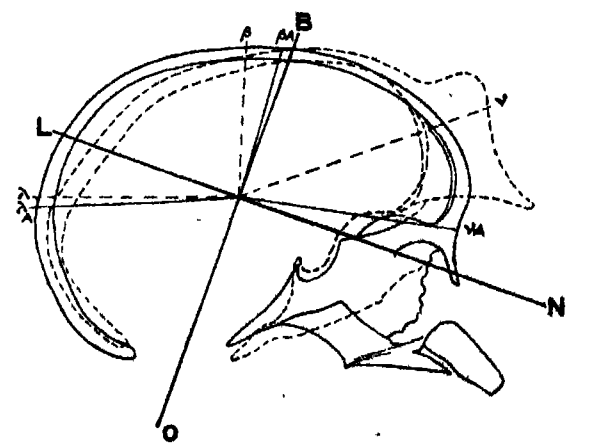


FIG. 3.—Sagittal sections of Taungs skull and skull of adult chimpanzee superposed. (× about ½.)

and this skull closely resembles in profile that of the chimpanzee of Fig. 1. The areas of the profiles are almost identical, and the frontal torus of the gorilla is only faintly expressed.

There is nothing in these observations which would lead one to conclude that the adult Australopithecus

possessed a much larger brain than any existing ape The gorilla, as shown by Selenka, has a brain of 400 c.c. in the young stage, when it possesses only the deciduous dentition, and it attains to a maximum of 590 c.c. in the adult. This, however, is a matter of only secondary importance. It is abundantly clear

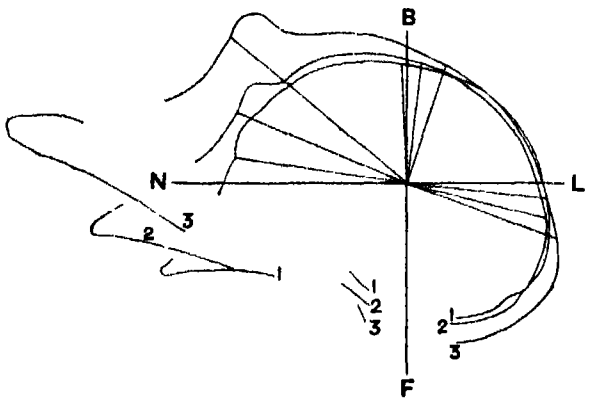


FIG. 4.—Profiles of the chimpanzee skull in different stages of growth

that in a number of significant morphological characters, such as complete absence of the frontal torus, position of the nasion, greater magnitude of the parietal arc, reduced prognathism and shortening of the maxillary region, Australopithecus makes a nearer approach to the Hominidæ than any existing anthropoid ape W J SOLLAS

University College, Oxford

The Discovery of Benzene.

IN view of the projected celebration of the centenary of Faraday's discovery of benzene in 1825, it is important that any doubt concerning his priority should be dispelled The standard work on coal-tar, Lunge's "Coal Tar and Ammonia," states on p 223, vol 1 of the fifth edition (1916). "It is usually stated that benzene was discovered in 1825, by Faraday, in the liquid separating from condensed oil-gas, but Schelenz (*Z. angew. Chem*, 1908, p 2577) has shown that the compound which we now term 'benzol,' or more recently 'benzene,' had been discovered in coal-tar forty years before Faraday in the year 1825 reported 'On new compounds of carbon and hydrogen. . . .'" Lunge then quotes from Schelenz three passages, culled from the chemical literature of the period 1740–1784, which in the opinion of both prove that benzene "was undoubtedly known forty years earlier" (although elsewhere in his article Schelenz refers to "Faraday's discovery, of which England can indeed be proud"). The citations from the eighteenth century are from German versions of Macquer's "Dictionary of Chemistry" (Leipzig, 1783), Demady's "Laborant" (Leipzig, 1784), and Caspar Neumann's "Prælectiones Chemicæ" (Schneeberg, 1740).

These works not being available, reference was made to similar English versions. In volume 1 of the English translation of the first French edition of Macquer's work (1766) we read (p. 166, footnote). "Fossil coal by distillation yields 1. a phlegm or water; 2. a very acid liquor; 3. a thin oil like naphtha; 4. a thicker oil, resembling petroleum, which falls to the bottom of the former, and which rises with a violent fire; 5. an acid concrete salt; 6. an inflammable earth remains in the retort." In volume 1 (p. 385) of "The Chemical Works of Caspar Neumann, M.D.," edited by William Lewis (second edition, London, 1773), the author states that 48 ounces of the best sort of pit-coal from Halle heated in a glass retort with a fire gradually increased, yielded 2 ounces 7 drachms of phlegm; 2 ounces and 1 drachm of a thin fluid oil, and 1 ounce of a thick, tenacious, ponderous, pitchy oil, which stuck in the neck of the retort; the residuum weighed 40 ounces 7 drachms . . That which distilled at first was light, and swam on water, the succeeding parcels proved more and more gross and ponderous, and at last sunk" The coarse stony pit-coal of Halle yielded no oil

These quotations will suffice to show that the chemists of that period knew how to obtain by destructive distillation of certain coals a number of loosely-defined *mixtures* as fractional distillates, but they afford no evidence whatever that the light-oil or any other fraction was known to contain a definite, homogeneous chemical individual, which we know as benzene Nevertheless, Schelenz states that Neumann certainly had benzene before him! Undoubtedly he had, but only as one constituent of a very impure mixture, and the preparation of a mixture which years later is proved to contain a hitherto unknown chemical compound does not constitute a discovery of that compound Has Liebig ever been credited with the discovery of bromine? He actually saw it years before Balard "discovered" it It is surprising that the statement in "Lunge" should have remained so long unchallenged, and it is fitting that at this time it should be given an unqualified and definitive denial

It might be contended that Faraday's title to the honour of discovering benzene is rendered doubtful by the fact that he did not obtain it in a pure state In his paper to the Royal Society (Phil Trans, 1825, p 440) Faraday admitted that his "bicarburet of hydrogen" was impure (C = 11 576, H = 1, compared with C = 12, H = 1, required by theory), probably because it contained another hydrocarbon containing 8 25 parts of carbon to 1 of hydrogen In this connexion it is interesting to compare Faraday's values of some of the physical constants of benzene with the values accepted to-day (Faraday's values are given first) sp grav 0 85 (at 15 5° C) · 0 8850 (at 15° C), melting point 5 5° C 5 483° C; boiling-point 85 5° C. · 80 2° C, density of vapour (H = 1) nearly 40 · 39 Allowing for different degrees of accuracy of the measuring instruments in use a hundred years ago and of those now available, the conclusion seems to be justified that, without any doubt, Faraday was the first to isolate benzene in a substantially pure state; and there has never been any question that he was the first to investigate its physical and chemical properties. F H TRIPP.

May 27.

Double Impacts by Electrons in Helium.

IN a paper on the precise measurement of the critical potentials of gases (Proc. Roy Soc, 107-291, 1925) Mr E. G. Dymond finds that the difference between the first and second kink in the current potential curve in helium is 20 9 volts and not 20 55 volts as one would expect if the first kink corresponds to electrons which have caused the transition $1S - 2s$ (type *A*), and the second kink to electrons which have caused two transitions $1S - 2S$ *and* $1S - 2s$ (type *BA*). In attempting an explanation he assumes that in his apparatus the second kink is due to the transition *BB*.

I would like to suggest in the first place that this disagreement is possibly explained when the energy lost by *elastic impacts* between electrons and helium atoms is taken into consideration, and in the second place that the double impacts are probably of the

type *BA* or *AA*, rather than of the type *BB* assumed by Dymond.

Taking up the latter point first, if it is assumed that at forty volts the probability of a *B* transition is greater than of an *A* transition, then I believe that the second kink is of the type *BA* and not of the type *BB* for the following reason. As the accelerating field is gradually increased in the neighbourhood of forty volts, the electrons *first* get enough energy to cause the double impact of the type *B* followed by type *A*, *before* they get enough energy to cause the double impact of type *B* followed by type *BB*. The double impact is then of the type *BA*. However, if it is assumed that at forty volts the probability of type *A* transition is greater than for type *B*, then the double kink will correspond to type *AA*. That is, the second impact of the first double kink will always be of type *A*. Of course as the field is further increased the type *BB* would, in the ideal case, appear as a second double kink 0·8 volt higher than the double kink of type *BA*. In this ideal case (no energy losses by elastic impacts and maximum probability of impact at the critical potential), the difference between the double kink and the single one would for type *AA* be 19·77 volts, for type *BA* 20·55 volts, and for type *BB* 21·33 volts, as has been assumed heretofore.

If, however, the energy losses due to *elastic impacts* are taken into account, then I arrive at the following relations for the energy spent by typical electrons which start out with the energies found by Dymond as corresponding to the first and second kinks.

For a single impact of type *A*

$$22{\cdot}2 + C = E'_A + 19{\cdot}77 + R_A \qquad (1)$$

For a double impact of type *BA*

$$43{\cdot}1 + C = E_B + 20{\cdot}55 + E_A + 19{\cdot}77 + R_A \qquad (2)$$

The left-hand side of both equations represents the *total* energy of the electrons, 22·2 volts and 43·1 volts being the points on Dymond's curves where the drop in current is most pronounced. The quantity C is the correction due to initial velocity. E'_A is the energy lost by elastic impacts which precede the inelastic one which a 22·2 volt electron makes. Similarly E_B is the average energy lost in elastic impacts by a 43·1 volt electron before it makes inelastic impact of type *B*, and E_A is the average energy lost by elastic collisions of the same electron *after* it has made its first inelastic impact (type *B*), and before it made its second inelastic impact (type *A*). In both cases $(19{\cdot}77 + R_A)$ is the potential at which the probability of type *A* transition is a maximum.

Subtracting equation one from two it is found that

$$20{\cdot}9 = 20{\cdot}55 + E_B + E_A - E'_A \qquad (3)$$

It is seen that the difference between the kinks is not equal to the critical potential, but that it differs from it by the quantity

$$(E_B + E_A) - E'_A = 0{\cdot}35 \text{ volt.}$$

A figure so large as 0·35 volt for the difference in the energy lost by elastic impacts in the two experiments does not seem unreasonable. It can be shown from the laws of the conservation of energy and momentum that a forty-volt electron loses 0·010 volts per impact with a helium atom, while a twenty-volt electron loses only 0·005 volt per impact. Hence, since Dymond estimates that an electron makes in the neighbourhood of a total of 400 collisions in passing through his apparatus, one need not be surprised by a difference of the order of 0·35 volt in the amounts lost by elastic impacts in the two different experiments.

If the above views are correct, it means that for a gas of small atomic weight like helium the usual method of correcting for initial velocity and contact potential, by taking the difference between kinks equal to a critical potential of the gas, is not permissible.

I am indebted to Prof. R. C. Tolman of this institute for the opportunity of discussing these matters with him.

GEORGE GLOCKLER.
(National Research Fellow in Chemistry.)

Gates Chemical Laboratory,
California Institute of Technology,
Pasadena, California, April 9.

I AM indebted to Mr. Glockler for his remarks on the influence of elastic collisions on the measurement of critical potentials, but I cannot agree with him that the loss of energy from this cause can with my apparatus result in a sensible error in the values of the excitation potentials of helium.

In analysing my curves Glockler has considered only the points where the rate of fall of current is at a maximum. This is not justifiable, however, as the retarding potential used between the plate and grid was 0·5 volt. This implies that the current drop at any point does not represent the number of inelastic impacts at that potential, but the number integrated backwards over a range of 0·5 volt.

If, however, we deal, as in my measurements I have done, with only the first break points, a little consideration will show that energy loss by elastic impacts can play no rôle but that of reducing the region in which an electron can effectively collide; that is to say, that it can only reduce the probability of inelastic collision, as at the critical velocity any energy loss renders the electron incapable of exciting. This means that inelastic impacts first take place in the neighbourhood of the grid and gradually spread throughout the apparatus as the voltage is raised. The reasoning, of course, applies alike to the single and double impacts.

This independence of the position of the kinks on the loss of energy by elastic impacts is a property of the type of apparatus used. Benade and Compton (*Phys. Review*, 11, p. 284, 1918) have, of course, shown that when a number of collisions can take place during acceleration of the electrons, the position of the kinks is a function of the pressure, but in the apparatus used by me the electrons are accelerated to their full velocity before making any collisions.

The reduction in the probability of effective collision for voltages immediately in the neighbourhood of the critical potential will certainly make the kinks less sharply marked, but I think that an inspection of my differential curves will show that an error of 0·1 volt is the most which can be made from this cause.

E. G. DYMOND.

Zweites Physikalisches Institut der Universität,
Göttingen, Germany, May 8.

Possible Effects on Marine Organisms of Oil Discharged at Sea.

THERE have recently appeared in the Press imaginary descriptions of devastations caused among larval fishes and other marine organisms by oil floating on the sea. So far as the present writer knows, these descriptions—some by influential writers—are anticipations of what might occur if oil were a moderately poisonous substance. Oil is certainly noxious, and the writer is fully in agreement with the descriptions which have been given in the Press of the disgusting conditions due to it at high-water mark along our shores and sometimes also at sea, but there is

little evidence as yet to show that the kind of oil lost or discharged at sea is even mildly poisonous. For this reason it is necessary to adopt a much more agnostic view than is at present current with regard to the effect of oil on marine organisms The kind of oil used for fuel on ships at sea is, I am informed, entirely petroleum oil in its crude state or the residue left after the separation of its more valuable and lighter constituents; but it is unlikely that much of these oils will escape or be knowingly discharged from ships, except the heavier residues along with waste lubricating oil. Until it is known what chemical constituents this waste oil contains, it is premature to imagine that it has any serious harmful effect on marine organisms. The more poisonous coal-tar oils are apparently not used as marine fuel oils.

Experiments by Orton and Elmhirst on petroleum residues, taken from masses of this material floating on the sea, indicate—as do some chemical analyses by the Government Chemist—(see Orton, Fisheries Investigations II, 6, No. 3, pp. 134–145)—that these oils are practically non-lethal, either directly from toxic constituents, or indirectly from their physical properties Indeed, it is doubtful if these substances are as poisonous as human urine These samples of oil, however, are only two of a large number which require to be tested before previous contact with sea water.

The effect of a lubricating oil on marine organisms was observed by the present writer on a wreck, ss. *Rock Highland Bridge*, which sank off Falmouth Harbour and was moved inshore to the mouth of the Helford River. This wreck had not been an oil-burning vessel, but oil was escaping in small globules from the engine-room and had covered the starboard side of the vessel amidship with a coat of congealed oil for about ten yards This oil was smeared over a quantity of young mussels and limpets (Patella), which were found to be clean and healthy and approaching sexual maturity. A number of fishes—pollack, gobies and smelts—were swimming close to the rising oil and below the oil film, and also close to the oily side of the vessel was found a shoal of copepods, mainly *Calanus finmarchicus*, which is notoriously an inhabitant and apparently a lover of good clean water. The mussels mentioned above were stunted in growth, it is true, but dwarfing in situations near high-water mark—as these were—is well known (see Orton, Jour Marine Biol. Assoc., vol 10, 1914, p. 319). Thus from actual experiments and observations on certain oils there is ground for taking the view that—apart from actual contact with oil, and not always even then—oils such as are lost at sea are not very dangerous to marine life.

It is an obvious and deplorable fact that birds which become fouled with oil have died and are still dying off in consequence in considerable numbers, but there is little ground for statements that any organisms on the shore are being killed off in wholesale fashion It is indeed rare to find objects smeared with oil on the shore anywhere below about high-water neaps. A thick oil may become entangled in a branching wet surface, such as some seaweeds offer, but not easily.

Even water-gas tar, which is known to contain poisonous constituents, was found by Mitchell (Bull. U.S. Bureau of Fisheries, 32, p. 199, 1912) to be harmless to oysters in running water, though the tar had previously been *injected* into the mantle-cavity of the bivalve. The explanation of this is probably simply that the tar was immediately or soon shot out of the precincts of the shell and was unable to adhere in any significant amount to any of the soft parts, which are, normally wet and covered with a film of mucus which is easily sloughed.

If one supposed that oil contained a fair amount of soluble poisonous substances, the fact that oil forms a film on the surface of the water would cause the toxic substance to be exposed to immediate dilution which would soon become great in any tideway If, on the other hand, fish eggs, for example plaice eggs, were floating near the surface under a layer of oil in a rubbly sea, it seems possible that globules of oil may come in contact with the eggs or larvæ, but if they did, would they envelop them and kill them? If potential fishes were killed in this way, what area of the ocean would be affected by the oil and to what depth in these areas would the oil affect living organisms? All these questions are relevant, and no doubt answers to some of them could be obtained by simple laboratory experiments

One further fact of interest was observed in my own experiment with a petroleum residue taken from the sea. After about six weeks contact with sea-water, the oil hardened into a scum and began to sink, but before it sank crowds of a small white polychæte (Ophryotrocha) were found eating the scum of oil—probably for the sake of the bacteria feeding on the oil in turn Ophryotrocha is a notorious scavenger, and is frequently taken in thousands from an old boot dredged up from the sea Some oils, therefore, add to the available food-material in the sea, and it is clear that further information is required before we can actually gauge the effect of oil upon the sea on the life below the surface. J H. ORTON

The Laboratory, The Hoe,
Plymouth, May 19

Salps and the Herring Fishery.

RECENTLY the chairman and one of the scientific staff of the Fishery Board for Scotland, after two seasons (1920 and 1921) in which the shoals of herring had been scarce in their usual haunts, published communications in which it was suggested, though not distinctly asserted, that certain Atlantic currents had filled the usual grounds with hordes of salps—to the detriment of the herring By and by it was pointed out by those familiar with salps and their life-history that such a suggestion was untenable. Now, we have an article (*Scotsman*, May 5) in which Mr Arthur Samuel, M.P., Minister for Overseas Trade, again revives the subject, and by using the term "jelly-fish" for the salps has not added to the simplicity of the matter, for salps are in no way connected with jelly-fishes in structure, mode of feeding, development, or life-history.

This confusion is seen in the letter Mr Samuel gives from the American Fish Commissioner, who descants on the voracity of the jelly-fishes, so long ago humorously told by Edward Forbes, which leads them to engulf forms much higher in the animal scale than themselves, *e.g.* young fishes. So much is this the case that if the tow-nets and collecting vessels are not quickly attended to, the small jelly-fishes and ctenophores (Thaumantias and Pleurobrachia) levy a heavy toll on the young fishes.

But salps do not feed like jelly-fishes and their stomachs are ill-fitted for such a diet. The American author, indeed, suggests that the currents which conveyed the salps to these regions probably caused the migration of the herrings, though this is still in want of proof. He adds a word in favour of the jelly-fishes in so far as certain young fishes shelter under their discs, and he might have supplemented this by the fact that the Japanese dry and eat certain forms.

These facts, however, are altogether beside the question of the effects of hordes of salps on the herring

fishery; and Mr. Samuel concludes that he is "not certain that salps were the direct cause of the ill effects of our herring fishery," though he goes on to say that salps may consume the minute organisms on which the herring feed, a statement also requiring proof. He supposes that the salps float on the surface of the water only—which they certainly do in fine, calm weather with a smooth sea, their contractions breaking the surface like tremors on molten glass. But the moment a storm of wind and rain sets in they disappear from the surface, and they may be beached in long lines six or more inches deep on the tidal margin like masses of boiled sago. In ordinary calm weather, again, one might look from a boat into the deep water of the Hebridean lochs and observe at all depths chains of salps and solitary individuals moving slowly therein as well as at the surface. Indeed, when the climax of the invasion was reached the sea in Lochmaddy for long distances resembled boiled sago, and with every stroke of the oars the salps rose from the water and rolled like glassy crystals from the blades. Further, swarms of gulls swooped down on the larger salps and picked out the nucleus (containing the stomach and the heart), leaving the victims to continue their slow, gliding motion as if nothing had happened. Moreover, many of the littoral animals greedily feed on the salps, even the little stony coral (Caryophyllia) having its soft tissues above the corallum distended to bursting with salps.

What the gulls and invertebrates delight in, surely fishes, and more especially herrings, do not despise, for, as first suspected by Dr. H. C. Williamson, long on the scientific staff of the Fishery Board for Scotland, and now on that of the Canadian fisheries, the herrings, less adept than the gulls in dissecting out the nucleus, swallow the salps—nucleus and all. Instead, therefore, of being a scourge, which swept the herrings from their wonted haunts, the salps would rather prove a welcome source of food.

W. C. McIntosh.

Vernier Wireless Time-signals.

The Colaba Observatory has had under regular observations the time-signals broadcasted from Eiffel Tower and Nauen. A good deal of confusion was sometimes caused when the Observatory clock, which showed almost perfect agreement with the ordinary signals (old system) transmitted from Eiffel Tower between 22 hr 44 min and 22 hr 49 min G.M.T., received here between 4 hrs. 14 min. and 4 hrs. 19 min. Indian Standard Time, showed a considerable difference, occasionally so much as 0·8 of a second, when compared about an hour later with the Nauen signals (international system), which end at Greenwich midnight. The rate of the clock is so small that during the interval of an hour the clock developed negligible error; the difference between the two stations was consequently considered unfortunate, although this difference was ordinarily small.

The question naturally arises what order of accuracy an observatory should attempt in its time determination. Both Eiffel Tower and Nauen transmit vernier time-signals which enable one to obtain very accurate comparisons, the probable error not exceeding 1/100 of a second, but if these two stations themselves differ by even 0·1 of a second, the accuracy attainable from the vernier signals becomes meaningless. As Eiffel Tower transmits the exact times of the first and the last of the series of 300 dots, and Nauen does not, and as Eiffel Tower time shows a better agreement with Bombay time, greater reliance has been placed by the Observatory on Eiffel Tower signals than on the Nauen. It would be interesting to know the experience of other institutions in this matter.

S. K. Banerji.

The Observatory,
Bombay, April 9.

The question raised by Mr. Banerji is certainly important from the point of view of exact astronomy, but it is not new. It was fully discussed several years ago, and at Rome in 1922 the geodesists stated that field operations with small instruments in the open did not show anything like the large range shown by the fixed transit circles of the leading observatories. It was conjectured that the confined air in the transit circle rooms might cause some *lateral refraction through irregular stratification*. At a recent meeting of the Royal Astronomical Society Prof. Sampson put the discordances down to abnormalities in the level determinations, but the Astronomer Royal found it difficult to accept this suggestion. It appears from Mr. Banerji's letter that he has missed the earlier discussion.

Part of the difference between the different national observatories arises from the use of different solar tables, and consequent difference in the reduction from sidereal to mean time. This amounts to as much as 0·06 sec.

There is the further point that the daily time-signals necessarily rest on *preliminary* values of the instrumental errors. There is not time to discuss these fully before sending out the signals. The error from this source may approach 0·10 sec.

Andrew C. D. Crommelin.

55 Ulundi Road,
Blackheath, London, S.E.3.

The Sound of Lightning.

Capt. C. J. P. Cave's letter in Nature of May 23 reminds me of a storm at Little Shelford in 1915. I had waited for it to stop before I cycled in to Cambridge, and I started when there was clear blue sky in the zenith. An unexpected flash struck from the rear edge of the cloud before I had reached the garden gate, and damaged a tree within a hundred yards of me, near the village post office. The thunder was almost immediate, but was definitely preceded by a noise which I said was like "a sudden rending of calico", Mr. Cave's "swishing" noise would also describe it. I was working on sound-ranging at the time, and thought the cause of the noise was probably analogous to the explosion wave, travelling faster than sound, which disturbs sound-ranging calculations for the last few yards of a gun's position.

W. Lawrence Balls.

The Orchard House,
Bollington Cross,
Near Macclesfield,
May 29.

Hypothecate.

If a man prefers long words to short, who shall blame him? If he thinks Greek compounds more suited to the style of a learned paper, let us not hurt his dignity by carping. But we have a right to ask that he shall use such words correctly. Therefore it may be urged without offence that the many who like to write the word "hypothecate" when they mean "suppose" should first look that word up in the dictionary.

One who has done so.

The University of Bristol.

OPENING OF NEW BUILDINGS.

ON June 9 their Majesties the King and Queen opened the new wing of the University of Bristol before a distinguished gathering of representatives of the city and surrounding counties. The magnificent tower (Fig. 1) and the new buildings were the gift of Sir George Wills and his brother, the late Mr. H. H. Wills, in memory of their father Mr. H. O Wills, the founder of the University. The scholarly genius of the architect, Mr George Oatley, upon whom the King has just conferred the honour of knighthood, is revealed in every detail

The building, with its imposing entrance hall, contains the main library of the Faculty of Arts and the extensive collection of medical works presented to the University by the Bristol Medical and Chirurgical Society It also contains the whole of the administrative departments, the great hall of the University, with its hammered oak roof and carved oak panelling, the Senate and Council Room, as well as lecture rooms and private rooms for the whole of the members of the Faculty of Arts.

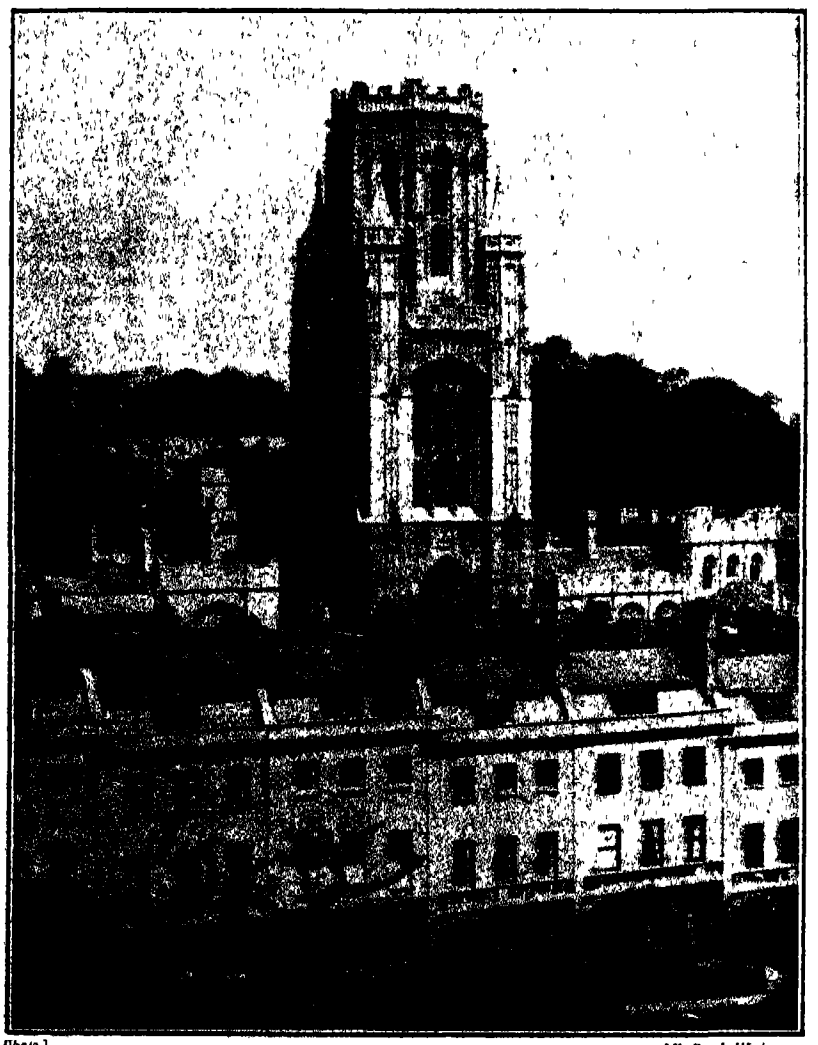


Photo [F. Reech Williams

FIG. 1.—The University Tower, Bristol, from Berkeley Square.

The University of Bristol, like so many similar institutions, arose from a University College founded in 1876, which was affiliated and later completely fused with the Bristol Medical School, founded in 1832. The University received its Charter in 1909. The Society of Merchant Venturers, which joined with the city in the petition for this Charter, gave its well-equipped engineering laboratories, and has since maintained the entire Faculty of Engineering as its gift to the common good. There are few institutions in Great Britain which can show such rapid growth in the brief period of sixteen years, part of which was occupied by a devastating war.

No sketch such as this can possibly pay personal tribute to the many administrators who laid the foundation or to the academic staff who created the reputation on which they built. There would have been no University had it not been for such men as Percival, Dean Elliott, Jowett, Temple, Procter Baker, Lewis and Albert Fry, Arrowsmith, P. J. Worsley, and H Napier Abbot on one hand; and Rowley, Marshall, Sollas, Silvanus Thompson, Lloyd Morgan, William Ramsay, Sydney Young, and Morris Travers on the other. It could not have come into being without the princely generosity of members of the Wills family, the financial assistance of the city of Bristol and the surrounding counties of Gloucester, Somerset, and Wilts, and the cities of Bath and Gloucester, all of which contribute from their rates

The Science and Medical Faculties of the University are already housed in other buildings and further developments for various sciences are in progress. The recent removal of the Faculty of Arts to the wing now officially open sets free a number of rooms adjoining the departments of geology, botany, and zoology into which they are expanding. That such expansion was a most pressing need can be realised by the fact that the chemical department, erected in 1910 and regarded at the time as not only complete but also adequate for all possible contingencies for thirty years, is now seriously overcrowded owing to the important schools of research it is called upon to accommodate. Still further relief will be afforded when the physics department leaves its present inadequate quarters and takes up its permanent home in the magnificent H. H. Wills laboratory in the grounds of the Royal Fort estate.

Again, the University has to thank the late Mr H. H. Wills both for the estate and buildings The erection of the physical laboratories on this commanding site has been progressing slowly but steadily, and they will be ready for occupation in about eighteen months. In this case also it would appear that provision is being made for its full growth for at least a generation, but the history of the chemical department leads any such statement to be received with caution.

The Royal Fort estate is beautifully situated on one of the highest points in Bristol, except for a portion now being used as an extension of the Botanical Garden and that occupied by the new physics buildings, no other sites have yet been earmarked, but it contains space for other departments which are certain to be wanted in the future, and these can be built without destroying the main features of the charming eighteenth-century residence and garden which forms a large portion of the estate, and so delighted the visitors who attended the garden party held there on June 9 after the opening ceremony.

Another delightfully situated eighteenth-century residence, Clifton Hill House, was presented to the University in 1909 as a hostel for women students, and was extended in 1911 by the addition of the adjoining Callender House. At present the men are accommodated in Mortimer House and Canynge Hall, but in the near future a magnificent hostel is to be erected by Sir George Wills on the far side of the Downs on an estate presented to the University by Mr. H. H. Wills close to the athletic grounds at Coombe Dingle. Finally, the students and staff are fortunate in possessing a well-known landmark in the city, the Victoria Rooms, in close proximity to the University, where their Majesties had lunch on June 9. These fine buildings have been bought, endowed, entirely modified internally, and presented to the University for the purpose of a Club, by the same generous donor whose name will be for ever remembered in the city of Bristol.

Metal Resources and the Constitution of the Earth.

SPECULATION concerning the origin of ore deposits has been for many years, and is at the present time, dominated by the school of theorists who attribute a proximate and direct igneous origin not only to igneous segregations, contact deposits, and the metalliferous vein-deposits immediately associated with igneous intrusions, but to metalliferous veins generally. The grip attained by this theory is such that only rarely do authors of papers take a larger and more comprehensive view of either the possibilities or the actual facts of vein-formation. The extent to which the mind of the average worker is obsessed by the igneous theory is shown by the tendency to apply it in cases where it seems almost certainly inapplicable In bedded iron-ores, sedimentary lead- and zinc-ores, and even petroleum, the igneous enthusiast sees clear evidence of metalliferous solutions and vapours rising through the earth's crust and effecting mineralisation at all levels on their way to the surface

When igneous rocks are present anywhere within reasonable reach of metalliferous deposits, the igneous enthusiast is of course particularly happy These igneous rocks may be miles away, but what does that matter? They may be entirely absent from the surface of a whole region; but that does not disturb his cheerful faith that somewhere the barysphere is bubbling. Indeed, at even shallower depths than the barysphere, are there not the seething metalliferous cauldrons of the magmasphere? The fact that both are well out of the way and far beyond the reach of observation comforts him rather than stirs his doubts, for on this account the barysphere and magmasphere are even more useful as a basis of speculation than they would be otherwise

The notion that metalliferous veins have been deposited by solutions and vapours escaping from the barysphere was first made attractive by Posepny, and was freely adopted by students of ore genesis, partly on account of its simplicity and plausibility, and partly because it was regarded as the only alternative to the theory of lateral secretion, which had been found wanting Though simple and plausible, however, it is almost certainly false, and the geological case against it was very fairly stated by Le Conte, in his contribution to the discussion on Posepny's paper. In recent years the igneous theory has gradually assumed a form in which it is more acceptable to geologists, the seat of the juvenile metals being fixed, not in the barysphere, but in ordinary rock-magmas originating at comparatively shallow depths In this form the igneous theory is just as simple and plausible as it was in the barysphere form, and it is more difficult to refute, although, as applied to most deposits, it is probably nearly as false; but if so, whence came the metals of the vein deposits and contact deposits so often associated with igneous intrusions?

This problem, which is not only interesting in itself on purely scientific grounds, but is also important in its bearing on metal resources, was considered by Sir Thomas Holland in his presidential address at the annual general meeting of the Institution of Mining and Metallurgy on April 23 The ground he took was the contrast between the small percentages of the less abundant metals in the earth's crust as a whole, and their percentages in ore deposits. Taking the average composition of igneous rocks calculated by Clarke and Washington (see NATURE, Aug. 19, 1922, p. 254) as the best data available, he pointed out that, according to these data, elements formerly regarded as rare, such as zirconium and cerium, are more abundant in the earth's crust as a whole than are the familiar base metals copper, zinc, lead, and tin. Again, nickel, which is produced in comparatively small amounts, is ten times as abundant as lead and some hundred times as abundant as tin.

Adopting the now apparently well-established view that the earth has a large core of nickel-iron, which is surrounded by silicate-rock shells decreasing in basicity from an inner shell of peridotite to an outer one of granite-gneiss, Sir Thomas Holland states that the natural home of the heavier metals is deep down in the core, and asks: "How then do they get to the surface

at all? Have they, since the earth settled down after Archæan times, been brought up in any appreciable quantity from great depths, or are we now dependent on the mere lateral segregation of small traces originally scattered residually through the outermost crust and left as the result of an imperfect gravitational adjustment when the earth passed from the molten to the solid state?"

Of the two rival theories, namely (1) that the metals have been brought from great depths in igneous eruptives, and (2) that the metalliferous deposits have been formed by the segregation of materials originally disseminated through comparatively superficial rocks, he remarks that they need not be mutually exclusive, and that they may be complementary, but after a consideration of the relative significance and merits of the two theories, he infers that only a small fraction of ore deposits show signs of transport from great depths, while the majority of those that are workable seem to be the result of simple lateral segregation, and even a large proportion of these are probably derived by segregation processes in the uppermost layers.

This view, which is probably the truth of the matter, so far as can be judged from the geodynamical evidence at present available, has an important bearing on the problem of the duration of supplies of metals Supplies of lead, tin, zinc, and copper are likely to be exhausted long before those of coal and iron, and Sir Thomas Holland thinks it unjustifiable to take an optimistic view of the possibilities as regards aluminium, for bauxite deposits are few and small, and it remains to be proved that the metallurgical treatment of aluminium silicates is economically feasible.

In the concluding portion of his address he made some interesting remarks on the present condition of geology as a science. He clearly agrees with the editor of the New York *Engineering and Mining Journal-Press*, who told us recently that geological science is in the doldrums. Geological science, says Sir Thomas, is at present experiencing "a reposeful interlude"; it is indulging a "siesta." In his opinion the geological imago is more likely to emerge from its chrysalis stage at the meetings of the Institution of Mining and Metallurgy than at the meetings of the Geological Society. It would perhaps be wiser to expect any development that may affect geology as a science to be less sudden and spectacular than the emergence of an imago. The development is more likely to be gradual. Nothing could contribute more effectively towards the desired change than regular and joint meetings for discussion by the various societies interested. Is it too much to expect that the Geological Society, the Mineralogical Society, and the Institution of Mining and Metallurgy will one day establish permanent joint sessions and meet periodically, even if infrequently, to discuss topics of common interest? There is much uncultivated common ground between them. Dynamical geology, petrology, and mineral genetics require to be welded together into a scientific whole. By meeting periodically to promote the attainment of this end, each of the societies concerned would, while widening its own outlook, help forward the development of science. Now or never is the time to make this move, when three such able and intimate colleagues as Sir Thomas Holland, Prof Watts, and Dr. Evans occupy the presidential chairs of the three societies chiefly concerned T. C

The Discovery of Benzene.

By Prof. JOCELYN F. THORPE, C.B.E., F.R.S.

IT is a fact not generally known that Faraday's early work at the Royal Institution was mainly of a purely chemical character and that it was not until later, about 1831, that he took up the study of electricity and magnetism, the branch of physics in which his more famous discoveries were made and with which his name is usually associated in the public mind It is evident, of course, that this bent towards the chemical side of science was determined by his early association with Sir Humphry Davy, for Faraday has left abundant records illustrating the influence Davy's lectures and personality had on him. He seems to have first attended these lectures in 1812 when, as a youth of twenty-one, he was still serving as apprentice to Mr. George Riebau, a bookseller in Blandford Street; later he sent Davy a copy of the notes he had taken, together with a letter in which he expressed a wish to abandon trade and adopt a scientific career. It was well for posterity that this letter did not meet the same fate as that of a similar one sent to Sir Joseph Banks, then president of the Royal Society, which remained unanswered; for Davy sent a kindly and encouraging reply which not only led to an interview between them, but afterwards to the offer of a post as assistant at the Royal Institution, the salary being 25*s* a week with the use of two rooms at the top of the house, the minute of the Managers recording this appointment is dated March 1, 1813. Faraday did not, however, remain long at the Institution, for on Sir Humphry Davy relinquishing his appointment as professor of chemistry in 1813, Faraday accompanied him as secretary during a tour through Europe which occupied the next eighteen months

It appears that Faraday had arranged with Davy prior to the tour that his post at the Royal Institution should be kept open for him, and to this he returned in April 1815, being in the following month appointed "Assistant in the laboratory and mineralogical collection and superintendent of the apparatus at a salary of 30*s*. a week," apartments also being granted him. From this date onward until the end of what may be termed the first period, which closed with his illness in 1830, his work was almost entirely of a chemical character. His illness seems to have prevented him from doing active work for nearly four years, and thereafter he devoted his genius to the development of electricity and magnetism, and seems to have abandoned all work on the purely chemical side. Nevertheless, during the earlier period he made many important discoveries, for it seemed impossible for

this versatile man to touch any branch of science without enriching it. Indeed, the initial conception of many of the principles underlying colloidal chemistry, catalysis and the diffusion of gases was due to him.

Faraday's first original work was published in the *Quarterly Journal of Science* for 1816, and dealt with the analysis of native caustic lime. His own comment on this paper, printed in his volume on "Experimental Researches on Chemistry and Physics," is interesting, for he says: "I reprint this paper at full length; it was the beginning of my communications to the public, and its results very important to me Sir Humphry Davy gave me the analysis to make as a first attempt in chemistry, at a time when my fear was greater than my confidence, and both greater than my knowledge, at a time also when I had no thought of ever writing an original paper on science" It is interesting to note, in view of the last remark, that during the next fifteen years he published as many as sixty important scientific papers, and that nine of these appeared in the Philosophical Transactions. An examination of the records shows, moreover, that he started his experimental work immediately on entering the Royal Institution, for in a letter to Benjamin Abbott dated April 9, 1813, that is, only about a month after his appointment, he described the work he and Davy had carried out on the composition of nitrogen chloride During these operations both investigators seem to have received injuries from the many explosions that occurred, but with characteristic tenacity they succeeded in determining the specific gravity of the liquid and several of its properties.

One of the most striking of Faraday's earlier successes was obtained in his experiments on the liquefaction of gases, for in 1823 he was able to prepare chlorine, sulphur dioxide, carbon dioxide, sulphuretted hydrogen, euchlorine and nitrous oxide in the liquid state, free from water. The experiments were carried out at some personal risk, as the apparatus used was unsuited to withstand the pressure needed. He returned to this work twenty years later, and, adding cold to pressure, obtained ammonia, sulphuretted hydrogen, and nitrous oxide in the solid state. He had hoped to liquefy oxygen, and had subjected the gas to a pressure of 60 atmospheres at a temperature of -140° F without success It was left to his successor to achieve this end, sixty years later, in the same Institution

In 1821 Faraday was appointed Superintendent of the House and Laboratory at the Royal Institution, although it is curious that in a letter written to R. Phillips dated May 10, 1836, he states, "In the Spring of 1823 Mr Brande was Professor of Chemistry, Sir Humphry Davy, Honorary Professor of Chemistry, and I, Chemical Assistant in the Royal Institution." Nevertheless, it is clear from the Managers' minutes that in February 1825 he was definitely appointed "Director of the Laboratory under the superintendence of the Professor of Chemistry" It was not until 1833 that he became the first holder of the Fullerian chair of chemistry. In 1820 he published the results of a most laborious and painstaking investigation on the alloys of steel, and in 1821 he described some new compounds of carbon and chlorine. In 1824, the year in which he was elected a Fellow of the Royal Society, he undertook, at the request of a committee appointed by the president and council, an investigation into the properties of optical glass.

The year 1825 witnessed the discovery of benzene, the centenary of which is now being celebrated. It appears that the Portable Gas Company condensed oil-gas (from fish oil) at a pressure of 30 atmospheres. A thousand cubic feet of gas yielded about one gallon of liquid hydrocarbons, and from these Faraday isolated a substance he called bicarburet of hydrogen, identical with the benzene of to-day. The importance of this discovery and its effect on the work of later investigators cannot be overrated. It showed, for example, that benzene is a product of the decomposition of natural oils, and led, indirectly, to the discovery made by A. W. Hofmann twenty years later that benzene could be obtained by the distillation of coal-tar

Probably no single discovery has had more effect on the development of the past hundred years than this, for it has led not only to the establishment of new industries in all parts of the world with the consequent employment of millions of workers, but has placed in the hands of every one materials hitherto either non-existent or obtainable only by the well-to-do. Dyestuffs, perfumes, explosives, drugs, and similar modern commodities owe their existence to Faraday's discovery, because, once he had shown that a pure chemical substance could be produced by destructive distillation, the attention of chemists in all countries was directed to the possibility of obtaining others in the same way Thus the isolation, in quantity, of benzene, toluene, the xylenes, naphthalene and anthracene from coal-tar was soon effected. Moreover, the influence which the discovery of the hydrocarbon had on the development of structural organic chemistry transcends that of any other substance, for benzene proved to be the keystone of "aromatic character" and the basis on which many natural products is built. The synthesis of natural indigo, to take one example of many, would have been impossible if benzene had been unknown

It is true that Faraday had no idea whatever of the value of the discovery he had made. To him it was merely an interesting scientific fact which as soon as established ceased further to interest him. Indeed, things could not have been otherwise, because structural organic chemistry was then non-existent, and no one dreamt that there was any connexion between fish-oil and colour. But it is the pioneer who shows the way, even though he may not be able to or desirous of following it himself, and the sign-post erected by Faraday directed to a country full of rich and desirable things that could be utilised for the benefit of mankind. Fortunately, organic chemical science was served during the nineteenth century by a body of investigators who combined a clear and far-sighted vision with a manipulative skill which is the envy of their successors, and it was in their hands that Faraday's discovery was made to yield its full fruit.

In this way, therefore, one of the least of the discoveries of this great Englishman was destined to have a far-reaching effect on the civilisation of our race. Faraday, in a lecture delivered at the Royal Institu-

tion in 1816, spoke thus: "Before leaving this substance, chlorine, I will point out its history, as an answer to those who are in the habit of saying to every new fact, 'What is its use?' Dr. Franklin says to such, 'What is the use of an infant?' The answer of the experimentalist would be, 'Endeavour to make it useful.' When Scheele discovered this substance it appeared to have no use, it was in its infantine and useless state; but having grown up to maturity, witness its powers, and see what endeavours to make it useful have done." Surely nothing better than this could be said of his own discovery of benzene.

Current Topics and Events.

THE King's birthday honours list includes comparatively few names which are well known in scientific circles. Among them are the following: *Baronet*, Sir John Bland-Sutton, president of the Royal College of Surgeons; *Knight*, Prof. J. Robertson, Medical Officer of Health, Birmingham, and professor of public health in the University of Birmingham; *G.B.E.*, Sir Frederic Kenyon, Director and Principal Librarian of the British Museum; Sir John Snell, chairman of the Electricity Commission; *K.B.E.*, Dr. J. S. Flett, Director of the Geological Survey of Great Britain and the Museum of Practical Geology; *C.B.*, Dr. G. Rotter, Director of Explosives Research, War Office; Mr. F. A. Stockdale, Director of Agriculture, Ceylon; *O.B.E.*, Mr. W. Bevan, lately Director of Agriculture, Colony of Cyprus.

To an unsectarian gathering in connexion with the centenary meetings of the British and Foreign Unitarian Association, Lord Oxford and Asquith gave an address on "Some Phases of the History of Free Thought in the Nineteenth Century". From the contrasted lives of Robert Owen and William Cobbett, he illustrated the stimulus of free inquiry and open debate. Both men were pioneers in free and independent thinking, and Malthus was another who faced the facts careless of the hostility of his fellows. The search for truth continues to be the most imperious as well as the most stimulating of man's intellectual needs, and the form of the quest which we are accustomed to associate with the phrase "freedom of thought" is marked by independence of authority and by courageous facing of the facts wherever they may lead to in the way of conclusion. Freedom of thought marks the man of scientific temper though he may not have anything to do with what is conventionally called "science." Freedom of thought usually means the resolute exercise of scientific methods, but there is, as Lord Oxford indicated, a continual danger lest science become itself an authority that shackles freedom. Thus, he said, no greater misfortune has happened in the history of our vocabulary than that the same word "law" should be used to designate the command of a sovereign authority and the generalisations of a Newton or a Darwin. We wish that this lucid thinker had gone further in his analysis of what freedom of thought really means. Thus it is clear that, as secure scientific formulation advances, the field for freedom of thought must decrease. A formula that has stood the test of time and is verifiable by all normally constituted minds who can use the methods may be subsumed in a larger formula, but it can never be contradicted or scrapped. It is not the subject of legitimate free thought. Much of the so-called free thought of to-day is the expression of ignorance and vanity.

THE Inter-State Post-Graduate Assembly of the United States and Canada is an organisation to which nothing in Great Britain precisely corresponds. More than 500 of its members were formally welcomed in London on June 2 by the Duke of York, at the commencement of a long round of lectures and demonstrations by distinguished members of the medical profession in Great Britain. A growth of no more than nine years, the Assembly at once emphasises a need which the advance of modern scientific medicine makes more and more urgent as time goes on, and goes far towards affording the means for its satisfaction. It is significant that Dr. Charles Mayo, whose name is so closely associated with the highest specialism, should be the mouthpiece of his fellow-American visitors, of whom 65 per cent. are men in contact with the people as general practitioners, and that on several public occasions during the past week he has deplored the over-luxuriant growth of specialism in medicine and urged the importance of the "common or garden variety" of doctor. There may be many things that our hospital wards, operating theatres and laboratories can show our American visitors for their professional good, but if they turn our attention seriously to the problem of co-operation between the highly trained specialist, in theatre or laboratory, whom Dr. Mayo calls the "accumulator," and the "distributor" of medical wares, they will have done as great a service to British medicine as any we can render to them. Sir Humphry Rolleston has done well to direct attention to the urgency of the problem of post-graduate education in London. The members of the medical profession, he says, are students all their days and are naturally most anxious to keep up with the ever-advancing tide of medical knowledge. But effective means for doing this in London have yet to be thought out.

IT would be impossible to summarise here the many admirable papers read at the meetings of the Inter-State Post-Graduate Assembly. Some figures given by Colonel L. W. Harrison, of St. Thomas's Hospital, London, concerning venereal disease are, however, of general interest. Treatment during the last four years has reduced the new cases of syphilis from 42,000 to 22,000. New infections of gonorrhœa have diminished from 40,284 to 31,272. Although the number of attendances at clinics has increased, the cost has steadily diminished and in 1923–24 the estimate was 90,000*l.*, less than in 1920–21, and the present cost is now 2½*d.* per head of the population.

The reverse side of the picture is seen in the difficulty of ensuring treatment for the infected, particularly among women; and it is still possible for many cases to occur in which a woman gives birth to one syphilitic child after another in miserable sequence

SINCE the departure of Capt. Amundsen from Spitsbergen on May 21 no news has, at the time of writing, been received from the expedition. While some uneasiness may be felt, there are no adequate reasons for supposing that he and his party have met with disaster He may have reached the Pole and landed on the ice in order to take observations, and then found it impossible to rise for lack of level ice It must not be forgotten that his heavily-laden aeroplanes required a run of about fifteen hundred yards before rising in King's Bay. In this event he is retreating on foot to Cape Columbia in Grant Land, where there is the first of several food depôts by which he could reach Etah in Greenland by the end of October and, after wintering, return to Europe next year On the other hand, it is not impossible that, contrary to expectation, Capt Amundsen continued his flight across the Pole to the coast of Alaska In this event, some weeks might elapse before news was received from him Another possibility is that he has found an extension of the Canadian Arctic Archipelago on the American side of the Pole and that he is engaged in exploration before he returns by air There is little likelihood of both machines having crashed, and their non-arrival may reasonably be taken to indicate that Capt. Amundsen has, for one reason or another, changed his plans If he is travelling on foot, no anxiety need be felt for so experienced a polar explorer, for although the food he carried would last only about a month, he could doubtless get a supply of seal meat with the weapons he took with him

IN the pioneer work which led to the introduction of natural science into general school education, Clifton College played a very important part At a time when chemistry and physics had not yet appeared upon the horizon of most schools, they were being taught at Clifton by men of the calibre of Profs. Debus and Worthington, Sir William Tilden and W A Shenstone, whose efforts were ably seconded by the then headmaster, Canon J M Wilson When the present laboratories were erected, they were the best school laboratories in the British Isles The rapid advances of the last thirty years, however, have rendered them inadequate and obsolete The Council of the College has, therefore, decided to build a completely new science block, which seems likely to restore to Clifton its traditional position in the matter of accommodation for the teaching of science The new buildings, which will stand on the site of the present Junior School, are to include two elementary and one advanced chemical laboratories, with similar provision for physics; a biological laboratory; four lecture rooms; research rooms for the head of the department and the senior physics master; a dynamo and battery room; a polarimeter room; a photographic dark room; a large science library; a physical geography room; and mechanics' workshops, etc. It is hoped that the buildings will be ready for use by September 1927.

THE second annual Report of the International Committee for Bird Protection (British Section) is a three-page pamphlet which briefly records the subjects which have been dealt with. These include the destruction of birds on Macquarie Island (south of New Zealand), the threatened extinction of the magnificent parrots peculiar to certain of the Lesser Antilles, proposed international measures for the protection of migratory species, certain aspects of the still persistent traffic in plumage, and the destruction of sea-fowl by oil. This last subject also forms the subject of a separately printed statement by the chairman, Mr H. S. Gladstone. It is one of great importance, for not only birds but also fishes and other forms of marine life, not to mention the amenities of seaside resorts, may be threatened, international agreement and firm action are urgently required. It may be mentioned that the Section consists of representatives of all the principal British societies and bodies interested in ornithological study or in the preservation of wild life

MR HOWARD CARTER, in his discourse at the Royal Institution on Friday, June 5, on "The Tomb of Tut-ankh-Amen, from Ante-Room to Burial Chamber," said that he proposed to deal mainly with the work of the second and third seasons. He gave a brief account of the Valley of the Tombs of the Kings and some aspects of the first part of the discovery, and then described the more important funerary furniture discovered in the burial chamber and shrines. This includes a unique palace lamp carved out of pure semi-translucent alabaster, a triple-lamp of floral design, which would appear to be the prototype of the three-branched candlestick of the Christian era; golden emblems of Anubis; a perfume vase of the King and Queen, a cosmetic jar still containing its cosmetic plastic and fragrant; and the gold stick of the king. An account was also given of the great yellow quartzite sarcophagus discovered beneath the four shrines, with its four winged goddesses, Isis, Nephthys, Neith and Selk, sculptured at the four corners in high relief, and of the golden coffin found within. This coffin, of anthropoid form, yet to be examined, is no doubt the outer shell of a series of coffins, one within the other, the last containing the mortal remains of the young Pharaoh Tut-ankh-Amen.

THE Swiss Society of Natural Sciences is holding its hundred-and-sixth annual meeting on August 8–11 at Aarau on the river Aar in Switzerland. The scientific proceedings will be distributed over sixteen sections devoted to various aspects of science, and a number of lectures are announced in the general programme. These include addresses by Prof. P. Karrer (Zürich), on cellulose and artificial silk; Prof. P. Niggli (Zürich), on the structure of crystalline material; Dr. E. Gagnebin (Lausanne), on Wegener's theory of the origin of the continents; Dr. E. Witschy (Basel), on sexual differentiation; Prof. L. Léger (Grenoble), on biological features of mountain streams; and Prof. A. Vogt (Zürich), on the significance in medicine of

research on inheritance. Excursions have been arranged to local places of interest. The president of the meeting is Dr. P. Steinmann, and the secretary, L. Kim, Aarau.

THE Italian Government and the International Institute of Agriculture have established a Joint Committee to organise a World's Forestry Congress, which will be held at Rome early in May 1926. Experts in forestry and representatives of the timber and allied industries are expected to attend from all parts of the world. The provisional programme of the Congress embraces a wide range of subjects, on which reports and papers will be read and discussed This programme and the regulations may be obtained on application to the office of the International Forestry Congress, Villa Umberto, I, Rome (10). Persons of any nationality may take part in the Congress, as ordinary members, on payment of a subscription of 50 French francs, which will entitle them to a free copy of the proceedings and other publications issued by the Congress. At the same time there will be held, in connexion with the International Fair at Milan, an exhibition of forest products and of the machinery used in the conversion of timber, which should prove of great interest. Various excursions to Italian forests will be planned to follow on the conclusion of the meeting of the Congress.

THE thirty-sixth congress of the Royal Sanitary Institute will be held at Edinburgh on July 20–25. The Duke of York has consented to become honorary president, and the Right Hon Sir John Gilmour, Bart., Secretary for Scotland, the president, will deliver his inaugural address on July 20 Already 675 delegates have been appointed from nearly 400 sanitary authorities from all parts of the British Isles; delegates will also be attending from Australia, India, South Africa, China, Egypt, France, Japan, the United States, New Zealand, Canada, Poland, and British West Indies The meetings will be held in the University. The congress will meet in sections covering various aspects of sanitary science, and a number of conferences have been arranged Among the subjects to be discussed are the Schick test and diphtheria, cancer, leprosy, and river and air pollution The lecture to the congress will be delivered by Sir Leslie Mackenzie, and the popular lecture by Dr. Charles Porter. A Health Exhibition, including appliances for housing and general sanitation, and matters relating to health and physical welfare, will be held in the Waverley Market. Visits have been arranged to works and institutions in and around Edinburgh. The programme can be obtained from the Secretary, Royal Sanitary Institute, 96 Buckingham Palace Road, London, S.W.1.

THE science of protozoology—particularly that part of protozoology which deals with the parasites of man and animals—occupies such an important sphere in human organisation, that it is surprising that no journal devoted to its study has hitherto appeared in Great Britain. Protozoological papers have had to find a place either in periodicals of pure zoology or general medical parasitology, or else have had to find their way abroad. There has now appeared, however, under the title *Protozoology*, a journal devoted to the parasitic Protozoa, published from the London School of Hygiene and Tropical Medicine, and the first number is already on sale It is a publication of the Institute of Agricultural Parasitology, which is under the direction of Prof R. T. Leiper, who is also responsible for the *Journal of Helminthology*, and it is intended primarily to supply a medium for the publication of original communications on the parasitic Protozoa arising out of the work of the Institute. At present it is proposed that it should appear as occasion arises as a supplement to the *Journal of Helminthology* The first part contains an article by Dr. J G. Thomson on a species of Giardia found parasitic in the intestine of a parasitic Nematode. A curious feature connected with this is that no Protozoa were found in the intestine of the host of the worm—a viscacha—although the gut of the nematode contained so many flagellates as to suggest a culture Miss M. Triffett contributes a most interesting paper on *Gastrocystis gilruthi*, a very common, though hitherto unsuspected, parasite of British sheep The same author also has an article on various species of Coccidia found in snakes which were dissected at the prosectorium of the London Zoological Society The articles are illustrated both by line-blocks and by half-tone plates This new venture fills a very obvious gap in scientific literature, and we hope that it will meet with every success

HIS Majesty the King will open the new house of the British Medical Association, in Tavistock Square, London, on Monday, July 13

LORD BLEDISLOE, Parliamentary secretary to the Ministry of Agriculture, will open the new plant pathology laboratories at the Rothamsted Experimental Station, Harpenden, Herts, on Thursday, June 18.

DR. C. D. WALCOTT, secretary of the Smithsonian Institution, Washington, D C, has been elected a foreign associate of the Brussels Royal Academy of Sciences.

WE regret to announce the following deaths:—M. Camille Flammarion, of the Observatory of Juvisy, Paris, widely known for his work and writings on astronomy, on June 4, aged eighty-three years; Mr. James Hunter Gray, K C, a leading counsel in electrical, chemical and general scientific cases, on June 1, aged fifty-seven years; Prof. Omer Van der Stricht, professor of histology and embryology in the University of Ghent, on May 8.

WE learn from *Science* that the Thompson Gold Medal awarded by the National Academy of Sciences for distinguished service in the sciences of geology and palæontology has been given this year to Dr. John M. Clarke of Albany. The Medal, which was established for the purpose of recognising the achievements of long service, has been awarded but twice before, first to Dr. Charles D. Walcott, and second to Emmanuel de Margerie. Dr. Clarke was unable to attend the presentation ceremony on April 29, and it was

with much regret that we recorded his death in our issue of June 6, p. 882

THE Science Society of China has issued a pamphlet describing its organisation and equipment with illustrations of its headquarters, including its large science library and biological research laboratory at Nankin The Society was founded in 1914 by some Chinese students in the United States It was incorporated in China in 1917 and since then has grown steadily, and now numbers more than 700 members The Government gave it some buildings in Nankin as headquarters and it has also centres in Pekin and Canton, and is negotiating for the establishment of a research physical institute at Shanghai It holds an annual conference in the summer, and has several useful committees on scientific education in China and on scientific terminology It issues a monthly periodical entitled *Science* The pamphlet is written wholly in Chinese

AN innovation at the Royal Botanic Gardens, Kew, is the issue of interesting series of postcards, reproductions in colours from photographs of living plants in cultivation in the Gardens The first four sets of this series, comprising twenty-four cards, are now available from the Publication Kiosk near Museum III in the Gardens With sets of six cards of similar subjects, such as insectivorous plants, orchids, rhododendrons, etc., descriptive folders are supplied, the set with description being issued at the very reasonable price of 1s. The descriptions supply brief notes upon distribution, points of particular botanical interest, and occasional notes upon cultivation The experiment is an interesting one, towards the popularisation of the floral treasures in the Gardens, and the cards, which can be purchased separately if required, should have a ready sale.

THE report of the National Illumination Committee of Great Britain for the year 1924 is concerned mainly with proceedings at the meeting of the International Illumination Commission, held in Geneva in July last A list of definitions and symbols adopted at this meeting is given in the report, and it is mentioned that sub-committees on heterchromatic photometry, colorimetry, and a vocabulary dealing with illumination have been appointed It is interesting to observe that the International Illumination Commission has approved in principle the adoption of the brightness of a black body, operated under specified conditions, as a primary standard of light, and the National Physical Laboratory has been asked to formulate suggestions for an accurate specification International sub-committees dealing with the lighting of factories and schools and motor-car headlights have also been formed Attention is also directed to the establishment of a sectional committee on illumination by the British Engineering Standards Association. Five sub-committees dealing respectively with photometers, nomenclature and symbols, illumination glass-ware, fittings and street lighting have been set up and are now holding meetings.

THE Report of the United States National Museum for 1924 records the accession of 362,942 specimens, this being well above the average (332,429) for the last fifteen years. The increase was particularly marked in the biological accessions and its value was enhanced by the scientific importance of many of the collections Chief among these was the private collection of Dr J. M. Aldrich, associate curator of insects, containing 44,610 specimens of Diptera, representing 4145 named species with type-material in 534 species. But in one way more notable was the transference to the National Museum of all the insect type-material in the custody of the Pennsylvania Department of Agriculture, comprising the holotypes of 14 species, cotypes of 6, and paratypes of 35 It is hoped that this example will be followed by other States, for, as it is justly urged, type-specimens deposited in a national museum are more accessible to specialists than when housed in State, or municipal, or private institutions, and are much safer since there is less likelihood of a change of policy It may be added that the fewer the centres in which such material is assembled, the greater is the advantage to the serious student

WE have received a copy of the second report of the Joint Benzole Research Committee of the National Benzole Association and Leeds University (1925) The report is divided into two sections, the first treating of the corrosion of brass, and copper by benzole, and the second of the use of active carbon and silica gel for the recovery of benzole from coal and coke-oven gas (Bayer process). A complete bibliography for the years 1923, 1924 is included.

THE journals of F. Martens, the seventeenth-century naturalist traveller, are being republished by Dr W Junk, Berlin. His journey in the year 1671–1672 to Spain and the Canary Island was of less importance than earlier journeys to Greenland and Spitsbergen, but it enabled him to make a number of valuable observations. The journal is illustrated by many beautifully executed plates of scenery, plants, and fishes, but the editor has not added any notes

No 47 of the Bulletin of the National Research Council of the United States consists of a classified list of Bibliographies of Physics published either as separate bibliographies or more commonly as references in books or in articles in scientific periodicals during the years 1910–22. The list has been compiled for Research Information Service by Dr. K. K. Darrow, of the Research Laboratories of the American Telephone and Telegraph and the Western Electric Companies It has been found undesirable to follow the system of classification adopted in the International Catalogue of Scientific Literature, owing to the number of new subjects of investigation which have been opened up since that system was devised. Thus relativity, quantum theory, and radioactivity are included in the general physics, while the properties of α, β, and γ rays are treated under electricity Where the bibliographical value of a book or an article is high, an asterisk is prefixed. As an example of the extent of the list, we may mention the section on X-rays, which covers 3 pages, and is

classified under 20 headings. The whole list covers 95 pages and is followed by an index of 6 pages.

THE Cambridge Instrument Co., Ltd., is issuing convenient sized booklets describing the latest types of instrument which the firm produces. Booklets Nos. 3 and 4 are devoted to direct current and alternating current instruments respectively Wherever possible, sensitivity data accompany the descriptions, and will prove helpful to intending purchasers. The figures given are not necessarily the best, but are those which can be easily obtained. A new form of Duddell oscillograph is described. It is easily portable and enables three simultaneous records to be obtained although only one source of light and one camera are required. Another novelty is the Campbell frequency meter. It should be of value in telephone work, as it enables accurate measurements of frequencies between 180 and 4000 cycles per second to be made. The condition of balance is indicated by silence in a telephone, and the frequency is found by multiplying the reading on the scale by a simple factor, depending on which of the five ranges is used. Various types of apparatus suitable for telephone engineers are made, and electrical engineers will be interested in the fault localiser, the lightning conductor bridge, and the Epstein testing square.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: a lecturer in mathematics and mechanics at the Stockport Technical School—The Principal (June 24). Three assistant inspectorships in connexion with agricultural, dairying, and horticultural education and research (two with practical experience in agriculture and who have specialised in dairying, and one who has specialised in horticulture)—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 29) An assistant chemist at the Fruit and Vegetable Preservation Research Station of the University of Bristol, at Campden, Glos.—The Registrar, University, Bristol (June 29). A microscopist at the Technological Research Laboratory of the Indian Central Cotton Committee, Bombay—The Secretary, Indian Central Cotton Committee, 25 Wodehouse Road, Fort, Bombay (July 5). An assistant in biology at University College, Galway—The Secretary (September 18) Assistant entomologists under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 Keeper of the laboratory of the Royal Horticultural Society at Wisley—The Director, R.H.S. Gardens, Wisley, Ripley, Surrey.

Our Astronomical Column.

ORKISZ'S COMET.—Prof. Banachiewicz and his assistants have made a careful study of the orbit of this comet, using 80 observations extending from April 3 to May 27

T	1925 April 1·4782 G.M.T. (new)	
ω	36° 9′ 15″	
Ω	318 3 11	1925·0
i	100 0 46	
log q	0·04505	

Actually they give the elements not in the above form, but in *Cracovians*, a name that they have given to the direction cosines of the major and minor axis of the orbit, and the normal to the orbit plane. It is shown that some of the computations are simplified by using this form. No appreciable deviation is found from a parabola, so identity with the comet of A.D. 1500 is excluded. The following outline ephemeris is given:

	R.A.	N. Decl.
June 4	6h 15m 57s	81° 38′
July 6.	10 10 15	60 57
Aug. 7.	10 54 24	47 49
Sept. 8	11 23 55	40 11

THE KODAIKANAL OBSERVATORY IN 1924.—The report of the Kodaikanal Observatory for the year 1924 emphasises the importance of this observatory for solar work. Photographs on a scale of 8 inches to the sun's diameter were taken on 328 days. Monochromatic images of the sun's disc in K light were obtained on 329 days, prominence plates on 290 days, and photographs of Hα disc plates on 294 plates. Three important features are brought out on the last-mentioned plates, which appear to be typical of sunspot disturbances. An account of these was recently presented to the Royal Astronomical Society by Dr. T. Royds. They are (1) a bright ring round the sunspot; (2) outside this a dark flocculus more or less extensive; and (3) between the dark flocculus and the coarse réseau of the general undisturbed surface of the sun there is a bright surround consisting of bright patches larger than in the general réseau, interspersed by dark features sometimes suggestive of the spot vortex The study of these phenomena is being continued The sunspot activity showed a steady increase since the previous year, the approximate mean latitudes of the spots being 23°·7 in the northern hemisphere and 24°·0 in the southern. In the laboratory a series of comparisons of the solar spectrum with arc spectra was obtained for subsequent measurement for displacement of the solar lines

SPECTROSCOPIC PARALLAXES.—It is interesting to note that the Stonyhurst College Observatory has published its first paper on spectroscopic parallaxes (Monthly Notices R.A.S., vol. 85, p. 444), and the author, the Rev. H. Macklin, gives the values for 30 stars He explains that as only stars not fainter than about the third or fourth magnitude gave spectra intense enough for this purpose with the Stonyhurst instruments, sufficient material is not yet available for more than a preliminary examination The intensity-differences between the lines are measured by a wedge, the method adopted by the Norman Lockyer Observatory. At the latter observatory the luminosities and spectroscopic parallaxes of 1025 stars of types Fo to Mb, and 200 stars of type B, have already been published, the last 100 B-type stars appearing in the same issue of the Monthly Notices.

NEW LUNAR MAP.—Mr. H. Percy Wilkins has in preparation a lunar map of 200 inches in diameter in sheets of 22 × 30 inches. The detail is taken from all published drawings and notes, namely, Weinck, Elger, Gaudibert, Goodacre, Schmidt, and photos from Paris, Lick, Yerkes, and Mount Wilson. Objects down to half a mile in diameter are included. The sheets will be issued separately, so that any one requiring, say, the sheet containing Plato can have it without the others.

Research Items.

NEOLITHIC AGRICULTURAL IMPLEMENTS FROM CHINA.—In *L'Anthropologie*, T. 35, Nos. 1-2, P. Licent and P. Teilhard de Chardin describe two stone implements from an important neolithic site at Linn-Si, N.E. China, which are not only noteworthy in themselves but have a direct bearing upon a question of dating raised by Dr. Andersson in connexion with an implement found at Kalgan. The two implements in question are respectively 272 mm. long, 115 mm. broad, maximum thickness 16 mm., 355 mm. long, 117 mm. broad, maximum thickness 26 mm. The latter differs from the former in being polished. Certain well-marked abrasions suggest that both were fitted with handles, and it is probable that they were used as hoes. The implement found by Andersson, which resembled the unpolished implement from Linn-Si, impressed him by its Solutrean style, and he suggested that it might point to an upper palæolithic in China, but it is now clear that it must be classified as neolithic. A further point which emerges is the close affinity of these agricultural implements with those of North America. This had already been pointed out by Andersson in the case of the Kalgan implement, and is supported by Mr. Moorehead after an inspection of the Linn-Si specimens. They may therefore afford further proof that North America was peopled from Eastern Asia.

PHYSICAL CHARACTERS OF THE AUSTRALIAN ABORIGINES.—Dr. F. Wood-Jones and Dr. T. D. Campbell have published in the Transactions of the Royal Society of S. Australia, vol. 48, anthropometric observations, comprising thirty-five measurements in all, of ten South Australian aborigines, eight Kookata from the Stuart Ranges, of whom three are females, and two, a male and female, Ngunga from Streaky Bay. The skin colour varied from light to very dark chocolate, the eyes were dark or medium brown, the hair was black (except in two cases in which it was white) and wavy, though in two cases approaching straight. The head in length ranged from 165 to 200 mm., breadth from 130 to 146 mm., being dolichocephalic in all cases, and in height from 112 to 135 mm. To these measurements have been added measurements from various sources which bring the total number of individuals up to nearly two hundred. As a result of the comparative study of these figures, so far as at present completed, it is apparent that the Australian aboriginal is uniformly dolichocephalic, remarkably platyrhinic, has long forearms, and remarkably long legs from the knee downwards.

THE TRICHOCYSTS OF PARAMŒCIUM.—Mr. J. T. Saunders (Proc. Cambridge Phil. Soc., Vol. I., No. 4, April 1925) has investigated the trichocysts of Paramecium and concluded that they are the means by which this ciliate adheres to surfaces. When Paramecia are attracted, chiefly by the P_H of the water, to a particular spot, adherence takes place. The extrusion of the trichocysts is due to slight pressure such as may be set up by the Paramecia colliding with an object in the water. Verworn's view that the trichocyst consists of semi-liquid material which hardens on being extruded into water is adopted. The author shows that the tip of the trichocyst thread is sticky but the rest of it is not. Ciliary motion does not cease when Paramecium is attached by its trichocysts. The speed of movement, which is dependent on ciliary activity, is reduced when the P_H of the water reaches 8·0, and this reduction in ciliary activity results in the slender trichocysts being able to hold the organism fast. A further increase in the P_H of the water above 8·0 reduces the speed of the Paramecium so much that the force of the collision with an object is insufficient to cause expulsion of the trichocysts.

GOLGI APPARATUS, MITOCHONDRIA AND NUCLEI.—Dr. R. J. Ludford (Journ. R. Micr. Soc., March 1925) describes an improved technique the new feature of which is the employment of water at 35° to 38° C. for bringing about the reduction of osmic acid for demonstration of the Golgi apparatus. Dr. Ludford states that this method results in much less non-specific reduction than when the osmic acid is heated. The original paper should be referred to for details.

A GENETICAL STUDY OF THE FLAX PLANT.—A beautiful example of the application of pure science to practical problems is supplied by the very clear paper of Adelaide G. Davin and G. O. Searle, which appears in the Journal of the Textile Institute, Vol. 16, pp. T. 61-82, March 1925. As the result of extensive correlation studies they conclude that by ordinary selection methods it should be possible to isolate varieties of flax which are genetically distinct as to (1) flower colour, (2) time of flowering, (3) percentage of fibre, (4) length of stem, and (5) mean number of seeds per capsule. Also that it should be possible to breed new varieties of flax combining the qualities of tallness, high percentage of fibre and high mean number of seeds per capsule. From the practical point of view perhaps the most important facts appear to be the inheritance of variations in percentage of fibre and the fact that tall stemmed varieties contain more numerous fibres in each bundle of sclerenchyma, the fibres therefore being individually of relatively small diameter and with small open lumen. Probably such bundles of fibres have particularly valuable spinning qualities.

DROUGHT-RESISTANCE OF PLANTS.—It has been supposed that xerophytic plants are able to resist drought mainly by the reduction of their transpiration through special adaptations, such as hairs, thickened epidermis, and so on. N. A. Maksimov has studied the problem for several years, and according to him (*Journal of Experimental Agronomy*, Moscow, vol. 22, 1923) this is not the case. He has found, in fact, that the transpiration of xerophytes is, as a rule, far more extensive than that of typical mesophytes. Thus, xerophytes cannot be regarded as plants which are able to thrive under very dry conditions because of adaptations preventing loss of water through transpiration; their ability to resist drought depends not on their morphology or anatomy, but on some purely physiological characters. Amongst the latter most important are: (1) the high osmotic pressure of the juice in cells causing a powerful influx of water through roots; (2) the probable presence of special compounds preventing plasmolysis; (3) wilting of xerophytes occurs with a lower water-content than in mesophytes.

THE MORPHOLOGY OF THE CARPEL.—The traditional interpretation of the gynæcium of the flower as simply consisting of the union of modified carpellary leaves, by their margins when the ovules are parietally borne, by their folded flanks when the placentation is axile, with alternative suggestions as to the axial or carpellary origin of the central strand when this is left free from the ovary wall, is now under serious critical examination, thanks to the work of Miss Edith R.

Saunders. In a paper upon carpel polymorphism in the *Annals of Botany*, vol 39, 1925, pp 123-167, Miss Saunders gives reasons for thinking that widespread throughout the group of Angiosperms three different types of carpels can be found, all of which contribute to the making of the Angiosperm gynæcium She distinguishes these three types as—(1) the valve carpel, which retains the traditional leaf form, a row of ovules being borne upon each foliar margin, (2) the solid carpel, which in its most reduced form is nothing but a fibro-vascular cord with a few lateral veins (Such a carpel may project into the ovary cavity, giving rise to such a partition as the replum of the Cruciferæ When solid carpels are associated with valve carpels in a gynæcium, they are usually fertile and the valves sterile), (3) the semi-solid or pseudo-valve In this type the valve contour is maintained, but the placentæ, instead of lying at the margin, are displaced to the neighbourhood of the central line and the vascular system also consists of a double strand running in close connexion with the funicles of the ovules Many anomalies of stigmatic and stylar structure and arrangement receive a new interpretation at Miss Saunders' hands by means of these new conceptions of polymorphism in carpellary structure Doubtless this new view-point will be thoroughly examined by students both of floral morphology and systematics

THE DISTRIBUTION OF RADIOACTIVE SPRINGS — Seventeen springs in the Velay region of the Haute-Loire have been examined by M A Baldet (*C. R. Acad. d. Sci.*, Paris, March 30), who found that only three of them showed any considerable radioactivity The three streams in question lie practically in a straight line, the length of which is 44 km., and more recently a fourth radioactive spring has been discovered, in the former bed of a stream the course of which has been diverted by floods The new spring lies in the same straight line as the other three, so that it seems very probable that the distribution is not fortuitous, but that there is really a kind of long geological axis along which the strongest radio activity of the region is distributed This axis is nearly parallel to numerous lines of fracture in the surrounding country and to two ranges of volcanic hills An extinct volcano lies on the axis near one of the springs, as do portions of two river valleys

SPELLS OF ABNORMAL WEATHER — The presidential address to the American Meteorological Society by Mr. Willis I Milham dealt with "The Causes of Abnormalities," taking especially the year 1816, which in America has been styled "the cold year," and is often called "the year without a summer" The address is printed in the *Monthly Weather Review* for December Much has previously been written about this year, which, as a whole, is said not to have been "record-breakingly cold," but was chiefly exceptional for a very cold summer The possible reasons why 1816 was abnormal are considered There had been the violent volcanic eruption of Tomboro in April 1815, which ranks with the four or five largest during the last two centuries, while a weak sun-spot maximum also occurred during 1816. For the 23-year period 1816–1838, July 1816 had the lowest temperature on record and both May and June were the second coldest, while from March to September the monthly temperatures were below the normal. For another abnormality the warmth in America of December 1923 is considered, and it is suggested that possibly some change in ocean-surface temperature over a large area was the cause. At Greenwich, December 1923 was about 7° colder than the normal Mr Milham alludes to the "crying need for a weather map of the whole northern hemisphere, if not for the world" For some years now, 1910-1917, such weather information for the world has been published by the Meteorological Office, Air Ministry In support of Mr Milham's address it may be mentioned that in London the mean shade temperature in 1816 was 53° F in June, or 5° below the normal for 150 years; 54° 5 F in July, 7° below the normal; and in May and August the deficiency was respectively 3° 6 and 3° The July mean was the lowest on record June 1909 and 1916 are the only two Junes with temperatures so low as that of 1816 In every month during 1816 except September and October the mean temperature in London was below normal

COLOUR CINEMATOGRAPHY — Mr Claud Friese-Greene recently described his process of colour cinematography before the Royal Society of Arts, and his lecture is printed in the Society's Journal for May 1 It is a two-colour process, and the two colour images alternate on a single film, so that ordinary projecting machines suffice for showing them An ordinary motion picture camera has added to it behind the lens a rotating disc with two apertures in it, one filled with a colour filter that passes a very broad band of the red end of the spectrum, and the other filled with an opaque material except for a small opening that allows white light to pass and a "small portion of filter also passing light from the red end of the spectrum"—"in fact a pale yellow" In the positive print, the pictures corresponding to the first are dyed orange-red and the others are dyed blue-green The advantages of the method are that the tendency of greens to show of a brownish tint in two-colour processes is avoided, the cost of the prints is less than one farthing a foot more than that of ordinary black and white films, and "the time in turning them out" is practically the same Several examples were shown, and during the discussion that followed the lecture Mr Colin Bennett said that "the results were appreciably better than those arrived at by other commercial methods of colour cinematography"

PHOTO-ELECTRIC CONDUCTIVITY IN ROCK SALT — The phenomena of photo-electric conductivity in rock salt crystals which have been coloured yellow by the action of X rays, are similar in many respects to those which have been observed in the diamond and other crystals with high refractive index They are described by Dr R Gudden and Dr R Pohl in the *Zeitschrift für Physik* of March 17 Their observations were made in an electric oven, at temperatures of 30° to 40°, 60° to 80°, and 100° to 130°, the crystal being illuminated with light of short wave-length (405 and 436 $m\mu$ lines of mercury) with a potential difference of 800 volts applied to the electrodes At the lower temperatures the crystals are insulators when not illuminated The current starts without inertia as soon as the illumination commences, and drops at once nearly to zero when it ceases, this current is regarded as being due to the flow of electrons which have jumped from the phosphore particles, after absorbing radiant energy, leaving them in the excited state If now the crystal is illuminated with infra-red light, there is a rush of current, which quickly drops to a low constant value, this is regarded as being due to the drop of electrons, coming from the cathode side, into the positively charged phosphore molecules At the higher temperatures this action is facilitated by the thermal movements of the molecules, and at 100° to 130° there is practically no jump in the current when the red illumination is started, since there are no excited centres left when this takes place. Phosphorescence takes place when the second component of the current flows.

REFRACTIVE INDEX OF A MIXTURE.—Although there have been many attempts to establish a formula by means of which the refractive index of a mixture of two liquids could be calculated from the indices of its constituents and the amounts of each present in the mixture, none of them has been found applicable to all cases. In the issue of the *Physikalische Zeitschrift* for April 21, Prof. K. Lichtenecker claims that if the mixture involves no contraction, its refractive index μ may be calculated from the refractive indices μ_1, μ_2 of its constituents and the volumes v_1, v_2 of the constituents present in 1 c.c. of the mixture by the formula

$$\log \mu = v_1 \log \mu_1 + v_2 \log \mu_2$$

If contraction occurs on mixture, the value of $\mu - 1$ as calculated from this formula is increased in the ratio of the increased density to the density to be expected on the linear law from the densities of the constituents. So far, the new law has been tested on few mixtures, but for them it has proved correct to within one part in 10,000.

MEASUREMENT OF IONIC MOBILITY.—The April issue of the Journal of the American Chemical Society contains two papers by D. A. MacInnes and co-workers on the measurement of transport numbers by the moving boundary method. In the first paper a simple form of apparatus is described in which two sharp boundaries are readily obtained at each electrode, the apparatus is very suitable for use in university courses. Experiment shows that the results should be calculated from rates of movement of the two boundaries separately; it is not safe to rely on the ratio of the movements. In the second paper the apparatus previously described is improved and measurements made of the transport numbers of the anions in 0·1*N* solutions of potassium, sodium, and hydrogen chlorides. The results were 0·492, 0·3865, and 0·8320, respectively. The product of the transport numbers of the chloride ion and the corresponding equivalent conductivities for the solutions is constant, which shows that the salts in these solutions have equal degrees of dissociation at 25°. Previous work shows that the same holds at 18°. This dissociation is considered to be complete, so that the influence of concentration on equivalent conductivity is due to changes in mobility rather than in the number of ions.

ORGANIC SYNTHESES.—The suggestion has been made that "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, can increase its scope of usefulness by making available directions for preparations which have been submitted for future volumes. The following is a list of some of the preparations which are now being checked by the editors. Those who wish a copy of directions for some of the listed preparations can procure the same by writing to Henry Gilman, Iowa State College, Ames, Iowa. Acetamidine, acrolein, benzal pinacolone, benzylaniline, *m*-bromobenzyl chloride, *o*-bromotoluene, α-cyano-β-phenylacrylic acid, cyclohexyl-bromopropene, furoic acid, hydroxylamine base, *p*-iododimethylaniline, *p*-iodoguaiacol, mandelic acid, 1-methyl-2-pyridone, myristic acid, naphthaldehyde, phenyl isothiocyanate, symphthalyl chloride, propionaldehyde, pyromellitic acid, pyrrol carboxylic acid, thiophosgene, thymoquinone, *o*-toluamide, *m*-tolylene diamine, viscose.

MEASUREMENT OF RADIO SIGNAL STRENGTH.—The first accurate measurements of radio signal strength were made so far back as 1905 by Duddell and Taylor. An immense amount of experimental work has since been carried out all over the world. Many semi-empirical formulæ have been suggested for predetermining the signal strength, but they only apply roughly for a given range and for a given wavelength. An important paper on this subject by Capt. Round and his colleagues in the Marconi Co. was read to the Institution of Electrical Engineers on May 6. They give a complete report of the measurements made on signal strength over great distances during 1922 and 1923 by an expedition sent to Australia. They apply the latest scientific formulæ to their observational data, but with only very indifferent results. The complete theory of world transmission by radio has yet to be given. It is pointed out that at great distances the signals go round the earth in both directions, producing interference and "beats" in the receiver. The attenuation of the signals is less during night time, and so a louder signal may come by the long path. For example, with the American signals a bi-directional effect was clearly produced at a distance of only 13,000 kilometres from New York. A study of the Australian signal measurements leads to interesting conclusions. It was found that, in general, when using long wave-lengths, the signals going by the west to east path were stronger, and those going by the east to west path were weaker, than was expected. In the case of the Bordeaux signals the ratio was 5 to 1. In the case of transmission across the Atlantic, transmission from America to England is undoubtedly better than transmission in the reverse direction. This fact appears to contradict the usual reciprocal relations of optical theory, and the authors look to the future for the observational data still requisite before the phenomenon can be explained.

MEASUREMENT OF WATER DISCHARGE THROUGH SLUICES.—There has just been issued, in booklet form, two papers, by Dr. H. E. Hurst and Mr. D. A. F. Watt, of the Physical Department, Egyptian Public Works Ministry, presented to the Institution of Civil Engineers, in 1924, dealing with the measurement of the discharge of water through the sluices of the Assuan Dam. The first paper details certain experiments made to determine the similarity of the motion of water through sluices and through scale models, and the second is a record of actual measurements of the Nile during its higher stages made by a method depending ultimately on direct volumetric computation by means of a masonry tank. In the first paper, the authors conclude that the discharge of large sluices can be determined from models with an average accuracy as good as that obtainable by current meter measurements, the scale of the model to be adopted depending upon the product of the velocity in the actual sluice and its linear dimensions. They state that the limit of smallness in their investigations occurred with weir conditions when the head above the sill was about 3 cm., the depth about 2 cm. at the gate, and the velocity about 0·4 m. per sec. They suggest that until further experiments are made over a wider range, it would be well to keep the product of velocity, in centimetres per second, and smallest dimensions of the orifice, in centimetres, above, say 100, and in general not to use orifices of less than 3 cm. in their smallest dimension. In the second paper, it is stated that the method employed for measuring the flow of the Nile was to use current-meters of specially stout construction to plot the velocity-distribution in the types of sluice used to pass the flood. Useful results were obtained which showed that current meter measurements agree closely with sluice measurements, and, therefore, that the uncertainty about the correctness of current meter results in a deep and rapid stream is largely removed.

The Origin of Species as revealed by Vertebrate Palæontology.[1]

By Dr. HENRY FAIRFIELD OSBORN,

Senior Geologist, U.S. Geological Survey; Hon. Curator Vertebrate Palæontology, American Museum of Natural History; Research Professor of Zoology, Columbia University

"Discussions of evolution came to an end primarily because it was obvious that no progress was being made . . . We became geneticists in the conviction that there at least must evolutionary wisdom be found. . . The discontinuity of variation was recognised in abundance Plenty of the Mendelian combinations would in nature pass the scrutiny of even an exacting systematist and be given 'specific rank.' In the light of such facts the origin of species was no doubt a similar phenomenon. . . We cannot see how the differentiation into species came about. Variations of many kinds, often considerable, we daily witness, but no origin of species . . . That particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious" (William Bateson Evolutionary Faith and Modern Doubts Address in Toronto, December 28, 1921.)

IN the early part of the nineteenth century the geologists Hutton and Lyell, the masters of Darwin, overthrew the cataclysmic hypothesis of earth formation by the new uniformitarian doctrine in geology, "We must interpret the past by the present." Now is the time in biology to reverse this doctrine and demonstrate that we must *interpret the present by the past* This we owe to the discovery of continuous genetic phyla of both invertebrate and vertebrate animals, in which the evolution of the germ-plasm can be continuously traced

As distinguished from all observations in zoology, we deal in palæontology with secular evolution, *in which we observe the adaptive action and reaction of the heredity germ over long periods of time*. We also observe the secular action of natural selection (Darwin's selection factor), the secular direct reaction to environment (Buffon's factor), the secular adaptive action of habit (Lamarck's factor), the secular adaptive reaction to the living environment (Darwin's factor) As developed between 1893 and 1915 by Osborn, we must sharply separate Darwin's factor of selection, which has no energy content, and the above four energetic forces of evolution, namely, heredity, physical environment, living environment, and individual development or ontogeny.

Every organism develops through the normal interaction of these four forces, if either force is not normal the organism is not normal, if either force is progressive the organism will tend to be progressive; if either force is retrogressive the organism will tend to be retrogressive in the same manner Whereas in the transmutation of chemical elements and evolution of form in all the inorganic universe we have to do only with the action, reaction, and interaction[2] of internal forces and external forces, in the transmutations of life we have to do with these *four* complexes of energy: first, the internal potential energy of heredity as observed in phylogeny; secondly, the internal energy of the developing organism as observed in ontogeny; thirdly, the external energy of the physical universe known as environment, fourthly, the rapidly multiplying energy of surrounding plant and animal organisms, known as the biota From the beginning of life every typical organism is invariably developed under this quadruple principle, which is termed tetrakinesis in application to function, tetraplasy in application to form Thus, whereas inorganic transmutation may be twofold in its elaborate complexes of energy, organic transmutation is invariably fourfold in its elaborate complexes of energy.

Herein lies the first distinction between inorganic and organic evolution The second distinction is that before life appeared, the inorganic physico-chemico-mechanical content of our planet was exactly the same. Not a single combination of energy and matter in the entire planet was capable of resisting shock, of repairing waste, of combating disintegration, of co-ordinated resistance, consequently, the structural history of the inorganic planet was one of alternate construction and destruction The third distinction is that while the evolution of life advances by physical, chemical, and mechanical methods which we may more or less definitely measure and observe, this is only a half-truth, because living mechanisms differ from lifeless mechanisms, no matter how perfect, in being more or less self-adapting, self-repairing, self-perfecting, self-regenerating, self-modifying, self-resourceful, self-experimental, self-creative It is observed that these self-adaptive powers lie solely in the internal potential energy of heredity, while they may be evoked as reactions to changing physico-chemical environment, to ontogenetic experience, to the changing biota of animal and plant life Organs, tissues, and cells that have lost connexion with the heredity germ-plasm wear out exactly like other machines

Consequently, the prefix *bio* is essential; in living things we are dealing with bio-physical, bio-chemical, bio-mechanical phenomena. Life has a bio-physico-chemico-mechanical basis

The primary relation of these four bio-physical, bio-chemical, bio-mechanical actions and reactions, all involving energy, to Darwin's non-energetic principle of natural selection may be illustrated in the annual migration of the golden plover, *Charadrius dominicus*. Numbers of this species winter in Hawaii, where the oceanic climate is singularly uniform the year around, with no violent changes of season. The inborn impulse to northern migration is chiefly a bio-chemical process; the inborn sense of direction that guides the bird northward over two thousand miles of open ocean is chiefly a bio-physical process; the flight is bio-mechanical so far as the heart, the circulation of the blood, the bones, and the muscles are concerned, but bio-chemical in its energy supply. Under the severe struggle for existence all atypical plover probably drop into the sea, but under bio-mechanical self-adaptation every plover that completes the flight to the nesting-place is improved thereby, and in this process the whole race is annually standardised. This crucial, dominant bio-physical, bio-chemical, bio-mechanical period of flight transfers the bird into the breeding grounds, where new principles of natural selection prevail, especially in all the bio-chemical activities of the plover.

In this plover story we illustrate two fundamental principles of biology: first, as the primordial part of the process; the tetraplastic principle of the animal

[1] Address delivered before the National Academy of Sciences, Washington, on April 28.

[2] From E. B. Wilson's "The Physical Basis of Life" we quote a few lines embodying our idea of *reaction*: "No conception of modern biology offers greater promise for the physico-chemical analysis of vital phenomena than that the cell is a colloidal system; and that what we call life is, in the words of Czapek, a complex of innumerable chemical reactions in the substance of this system." Also of *interaction*: "It has been proved that the individual unit often affects the production not merely of one character, but of many. The converse probability is shaping itself that the production of any single character requires the co-operation of several or many units, possibly of all. . . . Every unit may affect the whole organism and all the units may affect each character. . . . The whole system may be involved in the production of every character."

mechanism developed by Osborn between 1893 and 1918, that all typical organisms depend upon the typical action, reaction, and interaction of the four complexes of energy, physical, chemical, mechanical Secondly, (*a*) Darwin's selection principle, whereby all organisms are constantly standardised in their adaptive actions, reactions, and interactions; (*b*) subsidiary to this, the Osborn-Baldwin-Morgan principle (1896–1898) of "coincident selection," whereby through heritable potentialities of self-improvement, self adaptation, etc, every race of organisms is not only standardised but also constantly improved, (*c*) the negative of Darwin's principle, the "cessation of selection" or panmixia of Weismann, whereby there is a gradual recession of unused or less used organs from a dominant to a subsidiary position in the life of the organism, finally to retention only in the germinal stage, (*d*) the internal bio-mechanism of selection, the "intra-selection" of Roux, whereby every element in the developing organism also has to contribute its quota or decline

While intensive observation by palæontology of successive genetic phyla of organisms demonstrates that the chief selection principle of Darwin is constantly operating in the rise and decline of all adaptive bio-mechanical organs, the subsidiary fortuitous selection hypothesis as originally conceived by Darwin leaves the greater part of the bio-mechanical evolution process entirely unaccounted for While we palæontologists observe great currents of continuous bio-mechanical adaptation which are actually going on in the heredity germ-plasm, we find no evidence either of chance or of discontinuity in the whole domain of bio-mechanical evolution. The surface ripples of fortuity as observed in De Vriesian mutation and the occasional waves of heritage variation observed in botany, zoology, experimental embryology, and genetics do not blind us to the continuous adaptive bio-mechanical evolution of each organism, even to the minutest bio-mechanical detail in each organ.

This statement is borne out in a recapitulation of the chief bio-mechanical principles of adaptation formulated from the time of Aristotle and of Empedocles to the present time, five of which were first observed in zoology and confirmed in palæontology, the remaining four principles having been observed only in palæontology.

(*To be continued*)

Periodicities and Predictions.

AN interesting paper by Prof Axel F Enstrom, Director of the Academy of Engineering Science, Stockholm, under the title "On Periodicities in Climatic and Economic Phenomena and their Co-variation," deals with the important question of extrapolating past climatic and economic data in order to predict future conditions In his introduction the author claims that "an investigation along these lines of the coal prices and the general prices" published by him in 1913 has been justified by the prediction of an economic boom about 1918 and a depression with the bottom about 1922 But it is doubtful whether this success really affords a corroboration, for these events must have been mainly controlled by the termination of the War, and were forecasted by methods independent of such an upheaval.

It is rather surprising that the author "earnestly warns" his readers against the "absolutely unreliable" process of drawing a mean straight line through a graph of annual values and producing it, for the advantages and disadvantages of the method lie on the surface, and there are occasions when it may give useful information.

Prof Enstrom points out that the ordinary plan of smoothing, say by 5 years, effects a bigger reduction in the amplitude of the shorter periods than it does in the longer: on the other hand, if we subtract each term of a series from the next the series of differences is free of secular change and the amplitudes of terms of short period grow by comparison with those of long period So when he is examining the temperature of London in relation to a period of about 9 years, which he calls the ϕ period, he smooths with respect to periods of 2, 3, 5, 11, and 13 years, and takes differences three times: and in order further to bring out the ϕ component he subtracts from the resulting series that got by smoothing over 9 years; he then applies an elaborate correction (including a smoothing by 19 years) for the sake of the residual terms. As we should expect after so much selective treatment, the graph is strikingly cyclic, though there are irregularities; and the author's conclusion is that the ϕ period is "not a homogeneous sine-wave of constant wave length but possibly a compound wave": there is, however, no comparison of the amplitude with what would be given by a purely accidental set of data, and no Fourier analysis of the periods between 8 and 10 years The question whether the period is compound is left unsolved.

In order to obtain a real basis for extrapolation in regard to the future, it seems clear that the series must be replaced by a number of harmonic terms, and extrapolation can only be made when it is shown that the series of harmonic terms gives a fair approximation to the original. The analysis of Prof. Enstrom appears rather complicated for the small amount of definite information that it provides regarding Fourier periods in the neighbourhood of 9 years.

A further departure is made in relation to "co-variation." After determining curves for the ϕ periods of two quantities in the manner already described, the correlation coefficient between these curves is obtained: as might be expected from the inevitable similarity, high coefficients are derived when the data of one curve are advanced or retarded so as to produce coincidence of phase. and obviously it is misleading to speak of these results, got by a process that in general removes most of the character from the original curves, as if they were derived direct from the originals themselves Thus it appears very unlikely that the variations of the yield of wheat in France are to any serious extent controlled by the length of the world's railways or control them; but by working out the ϕ curves of these two quantities and moving the latter forward two years a coefficient of 0·82 is produced which Prof. Enström considers as "indicating a very high degree of correlation"

The working out of possible periods exercises great fascination on many minds, and trustworthy information regarding them is of decided value to science. But Beveridge's complete working out of the periodogram of wheat prices in western Europe led him to the conclusion that prophesying was not possible on the facts as he gave them; and Brunt's equally thorough investigation of Greenwich temperature led to a similar conclusion Disappointment seems inevitable unless great care is exercised before domination by periods is announced, and we hope that the insight and industry of Prof. Enström will find further scope in their elucidation.

The Royal Observatory, Greenwich.

ANNUAL VISITATION.

THERE was a departure this year from the usual routine on the occasion of the annual visitation of the Royal Observatory, Greenwich, on June 6, for the Board of Visitors met at Dorking and inspected the new magnetic station at Abinger, which has been completed during the year.

A large number of invited guests were, however, present at the Royal Observatory and inspected the instruments. The report of the Astronomer Royal was presented, dealing with the twelve months ended on May 10, 1925

Fundamental observations have been continued as usual, the mean error of Brown's longitude of the moon in 1924 is −7 10″, practically identical with −7·12″ in 1923. The altazimuth is being used for observation of fundamental stars in the prime vertical, the results are in close agreement with those of the transit circle, indicating a mean correction of +0 25″ to Boss's Declinations between 12° and 50° N The usual observations of variation of latitude were made with the Cookson floating zenith telescope Application has been made to Cambridge Observatory for the renewal of the loan of this instrument for another seven years.

The 28-inch equatorial has been used for the measurement of 436 double stars, of which 37 were under 0 5″ separation Dr Steavenson observed Mars with this instrument last autumn, his drawings will be reproduced in the 1924 volume 266 stellar parallaxes have now been determined with the Thompson 26-inch equatorial, details of all of them are ready for publication.

The 30-inch reflector is being used for the determination of stellar temperatures, using a prism crossed by a grating Comparison is made with the positive crater of a carbon arc, which is mounted on the roof of the Octagon Room. The plates are measured in the micro-photometer, the results are stated to be encouraging. Four comets and two minor planets (including that of Baade) have also been observed both visually and photographically New plates are being taken with the astrographic equatorial for the determination of proper motions in the Greenwich Zone (Decl. 64° to 90°). Between Decl. 64° and 66° there are 54 proper motions greater than 20″ a century (of which 29 are new), and 231 between 10″ and 20″; there are 18,194 stars in the zone

There has been a considerable increase in sunspot activity; a spot in lat. 16° N. (on central meridian on May 6) was visible to the naked eye. Three papers dealing with the movements of spots and faculæ in longitude and latitude, and the rotation period given by long-lived spots, have appeared in the Monthly Notices of the Royal Astronomical Society

Magnetic observations are being taken in duplicate at Greenwich and Abinger to establish the relation between them. The values (at Greenwich) of Declension W., Horizontal Force, Vertical Force, and Dip for 1924 are 13° 22·8′, 0·18426, 0 43115, and 66° 51·7′, the annual diminutions are 11·5′, 0·00007, 0 00033, and 0·5′ respectively. The West Declension at Abinger is about 12′ greater than that at Greenwich; but this needs further investigation, as a defect was found in the Abinger instrument which has only recently been corrected.

The new standard sidereal clock, by Mr. W. H. Shortt, has been in use since January 1, and is very satisfactory; the master pendulum is in a vault under the Octagon Room, and the slave clock in the ordinary clock room.

Wireless time signals are received daily from Paris, Bordeaux, Annapolis, and Nauen. The first three are in the mean late on Greenwich by 0 07 sec.; Nauen is late by 0 02 sec.

The Astronomer Royal refers in his report to the astronomers who have visited the Observatory during the year Prof Lundmark and Mr Asklöf stayed for two months, studying photographic and parallax work, Mr. G. Merton is making a prolonged stay, being engaged chiefly in researches on cometary orbits Several others paid short visits

University and Educational Intelligence.

BIRMINGHAM.—Dr W N Haworth, professor of organic chemistry in the University of Durham (Armstrong College, Newcastle-on-Tyne), has been appointed professor of chemistry, and director of the department of chemistry

CAMBRIDGE.—Prof. A C Seward, Master of Downing College, has been re-elected Vice-Chancellor for the academic year 1925–6 Mr. H Banister, St John's College, has been appointed demonstrator in experimental psychology

In connexion with the forthcoming meeting of the International Astronomical Union at Cambridge, it is proposed to confer the honorary degree of Doctor of Science upon the president of the Union, President W W. Campbell, of the University of California; also upon Prof W. De Sitter, of the University of Leyden, Prof B Baillaud, Director of the Observatory of Paris; Prof H Nagaoka, of the Imperial University, Tokyo, and Prof F Schlesinger, Director of Yale University Observatory

At Trinity College the following appointments for 1925–6 have been made Mr Bertrand Russell to be Tarner lecturer in the philosophy of the sciences, and Major-General Sir Frederick Maurice to be Lees Knowles lecturer in military science.

The Statutory Commissioners have notified the University that they propose to modify the recommendation of the Royal Commission with regard to the proposed House of Residents as follows that if a Grace passed by this house involves a change of either statute or ordinance of the University, an appeal may be made to the Senate under certain conditions If in the vote in the Senate—the body of graduate voters including residents and non-residents—there is a majority against the Grace, the Senate's vote shall stand good (and the Grace shall be rejected), if in this second vote the majority against the Grace is larger proportionately to all the votes cast than the majority of residents' votes cast on the second occasion is to the total vote cast by the residents How this ingenious scheme, which restores the ultimate authority over statutes and ordinances to the whole Senate, will work out in practice, remains to be seen It may be hoped that it will not often be brought into use

Preliminary steps in the organisation of the proposed scheme of faculties are indicated by the Commissioners in a second memorandum on the subject of initial appointments under the scheme and the position of the present staffs of University and College lecturers. It is contemplated that the new scheme will come into force on October 1, 1926.

OXFORD.—On Tuesday, June 2, Convocation passed a decree conveying the thanks of the University to Dr. F. D. Drewitt, Christ Church, for his gift to the Hope Department of six volumes of the original water-colour drawings of lepidoptera made by William Jones of Chelsea, and known as "Jones' Icones." Jones' drawings and descriptions are of high value to students of systematic entomology.

Under the auspices of the Vice-Chancellor, preparations have already begun for the visit of the British Association to Oxford in 1926. Local secretaries have been nominated, and a meeting has been summoned for the purpose of appointing a local general committee.

DR. HAROLD A WILSON, F.R.S., professor of natural philosophy in the University of Glasgow, has accepted reappointment to the professorship of physics which he held at the Rice Institute, Houston, Texas, from 1912 to 1924 inclusive.

RESEARCH in secondary education in America has been enormously stimulated since the War by the stream of pamphlets, leaflets, and magazines issuing from the Bureau of Education. At a conference of representatives of the National Society of College Teachers of Education and other interested bodies last March, a programme of co-operation was discussed and steps were taken towards the constitution of a National Committee to initiate, direct, and co-ordinate research. The Bureau of Education will act as a clearing-house for information on the subject.

THE progress of educational research in the United States was extensively reviewed in the course of the proceedings of the education section of the American Association for the Advancement of Science at Washington last Christmas. A brief account is published in the February number of *School Life* of the scope of the papers—some forty or more—which were read on that occasion. The Americans are great experimenters, particularly in the very progressive private schools, in which the psychologist has a position and influence undreamed of in Great Britain. Among the more important of the large-scale experiments mentioned in the papers referred to is a progressive plan of grouping children by intelligence ratings that has been carried on in Detroit since 1920. In each of nine grades the children are divided into upper, middle, and lower groups, the upper and lower being each 20 per cent of the whole. Basic courses of study and standards of promotion are worked out for each group, and special teaching methods are applied to the upper and lower groups. The scheme is reported to have worked well.

A STATISTICAL survey of education, 1921–22, being advance sheets from the biennial survey, 1920–1922, has been issued by the United States Bureau of Education as Bulletin, 1924, No. 38. It gives a total school and college enrolment of 26 millions, with an estimated cost of 2000 million dollars. Enrolments in institutions under private management were as follows: kindergartens, 10 per cent. of the total, elementary, 6 per cent; secondary, 9 per cent., normal schools and teachers' colleges, 6 per cent., universities, colleges, and professional schools, 60 per cent; institutions of all kinds, 8 per cent. The estimated cost of the elementary schools is 1240 million dollars, of high schools 450 millions, and of universities and colleges 273 millions. The per capita costs of elementary and high school education were the same in private as in public schools, but the per capita cost of university education was 581 dollars in public and 364 dollars in private institutions. It is interesting to compare with these estimates the per capita cost of education in the universities and university colleges of Great Britain (excluding Oxford and Cambridge) according to the tables recently issued for 1923–24 by the University Grants Committee. Including part-time (14,245) and full-time (33,752) students, the cost per student is 74*l.* or, at the current rate of exchange, 354 dollars—almost exactly the same as in private universities in the United States.

Early Science at Oxford.

June 15, 1686. A letter from our President dated April ye 10th. was read; it gave an account that one Mrs Hoden had several times before the death of divers of her relations *dreamed* of the losse of two or more of her teeth, having had noe such dreams at other times.

Then was read an observation communicated by Dr Benbrig, concerning a gentleman who had a violent *paine* in his *ear* caused by maggots in it, a fly haveing blown in it the day before: Some milk being poured into his ear, at least sixty maggots came out, and the pain ceased.

Dr Edward Tyson, Dr. Tankred Robinson, Francis Aston Esqr, Mr. John Flamstead, Mr. St George Ash of Dublin, and Mr Christopher Pit of Wadham Coll. were elected members of the Philosophical Society.

June 16, 1685. A discourse of Dr. Robinson's, and a Letter of Mr Ray's, both concerning the French Marneuse, were read.

Mr Pulleyn brought in an abstract of ye way of making artificiall Amber, extracted from a MS in Magdalen Hall Library, it is as followes—

To make artificiall Amber.

Seeth Turpentine in an earthen pan well leaded, and put therein a little cotton, stirring it, untill it be as thick as paste, then pour it into what you will, and set it in the sun eight daies together, and it will be clear, and hard enough, you may make of this beads, hafts of knives &c. And when they are made so, set them to harden again in ye sun, and they will be very hard and clear.

A letter from Mr. Leigh giving a description and containing a draught of the Sepia, together with a paper written with ye naturall ink of that fish, was communicated. These things are sent up to ye Royal Society.

An accurate account with figures of a monstrous Cat dissected by Dr. Mullen of Dublin was comunicated in a letter from Mr. Ash, Secretary of ye Dublin Society, for which ye Society ordered their thankes to both these gentlemen.

A description and draught of an artificiall Fountain by Dr Papin, was presented from Mr Aston.

June 17, 1684. A letter from Mr. Aston, dated from London June ye 12th was read; a letter from Mr. Tancred Robinson, to Dr. M. L., concerning ye Bridg at Pont Esprit in France, was read. Dr Plott affirms, that ye Bridg at Burton in Staffordshire (which is one of ye greatest in all England) is built after ye same manner with that at Pont St. Esprit: this occasion'd some discourse concerning ye running of Rivers. It was affirmed that Medway runns ye least way of any river in England, of that bigness.

Two remarkable cases relating to vision were communicated by Dr. Plot, to whom they were sent by Dr Briggs of London; one of these cases was a *Nyctalopia*; a distemper not frequent amongst us.

It was affirmed, that Dr. Turberfeild of Salisbury has (not long since) met with a disease of ye eye as yet undiscovered, it was a bag of matter on ye outside of ye ball of ye eye, prominent from ye *tunica adnata*; the Dr. cured his patient, and called this distemper *Bursa Oculi*.

There being some Discourse concerning severall ways of makeing a *Spiritus fumans cum Aere*; it was ordered that a Spirit of that kind should be made, and an account of ye process brought into ye Society, which Mr. Bambrigg undertook to do.

Dr. Pudsey, Fellow of Magdalen College, and Mr. Alexander Cuningham of St. Leonard's College in St. Andrews, were proposed to ye Society.

Societies and Academies.

LONDON.

Geological Society, April 22.—W. L. F. **Nuttall**: The stratigraphy and palæontology of the Laki series (Lower Eocene) of parts of Sind and Baluchistan (India). Some of the massive white foraminiferal Eocene limestones of Sind, with a thickness of about 600 feet, found along the Laki Range and in Lower Sind, contain a different and earlier fauna of Foraminifera than that of the Kirthar series as exposed in the Kirthar Range. In the area near Meting the following divisions in the Laki series are proposed Laki Limestone, Meting Shales, Meting Limestone, Basal Laki Laterite The term Alveolina Limestone is discarded, as Alveolinæ are found in both the Laki and the Meting Limestones. The Meting Limestone is correlated with the Dunghan Limestone of R D Oldham, which is found in the Bolan Pass and other places in Baluchistan The Ghazij Shales of Baluchistan, which are absent in Sind, pass up conformably into the Lower Kirthar series The upper part of these shales is younger than the Laki Limestone In Sind the Laki Limestone is overlain unconformably by the Middle Kirthar, Nari (Oligocene), or Lower Manchar (Pliocene) beds The Laki series rests unconformably on the Upper Ranikot, with the upper members of the Laki series as traced northwards overlapping the lower The fauna of the Laki series, which is different from that of the Kirthar series, suggests that the former are of Lower Eocene age rather than Lower Lutetian, as has hitherto been supposed.

Linnean Society, May 7.—H. G **Cannon** The ectodermal origin of muscles in the crustacean, Chirocephalus In the trunk region of a metanauplius of Chirocephalus the limbs appear at first as pouch-like outgrowths, the ectoderms between them forming a series of ridges projecting into the body-cavity The inner edges of the ridges become nipped off from the more lateral ectoderm forming a string of cells containing deeply-staining fibrils. Later, dorsally and at the level of the inner face of the surrounding ectoderm cells, the fibrils lose their staining capacity and are replaced by a tendinous plate Below this plate the fibrils divide into segments, converting the strings of cells into typical striped muscles. These muscles do not appear to correspond to the larval mesoderm of annelids.—Miss I. **Andersson**. The genetics of variegation and leaf-structure in ferns. Spores being sown on Knop-agar, the several kinds of prothallia could be counted and observed continuously Segregation in respect of green or pale plastids may occur (1) at reduction, (2) during the prothallial growth, or (3) in somatic tissue of the sporophytes, or in any of these stages successively.—S. L. **Moore**: New species of Compositæ from Angola Land.

DUBLIN.

Royal Dublin Society, April 28.—H. H **Poole**: The photo-electric measurement of submarine illumination. A method is described of using photo-electric cells for submarine photometry which may be employed in a comparatively small vessel at sea in fine weather. The photo-electric current is passed through a known high resistance, the P.D. between the ends of the latter being balanced against a potentiometer. A telephone is used as a detector instead of a galvanometer, thus rendering a steady support unnecessary. This is effected by including a special form of interrupter in the detector circuit of the potentiometer. This circuit also includes the primary of a two-valve amplifier, the output terminals of which are connected to the telephones A vacuum photo-electric cell is used as a standard, the submarine illumination being measured by a cell of the Kunz type The effects of obliquity of illumination and of reflection losses at the photometer window are specially considered Preliminary tests have given satisfactory results.

Royal Irish Academy, May 11.—Miss A L. **Massy**. An account of the Brachiopoda taken by the fishery cruiser *Helga* off the Irish coast, with a summary of previous Irish records Eleven species are recorded, two from depths of more than 1000 fathoms, seven between 70 and 700 fathoms, and two from shallow water.

EDINBURGH

Royal Society, May 11.—F A E **Crew**: Unilateral vasoligation on the senile male of the domestic fowl Unilateral vasoligation in the fowl is not followed by rejuvenation phenomena This suggests that the gonad of the bird is not endocrinologically equivalent to that of the mammal.—Miss Sheina M **Marshall**. Plankton of the Firth of Clyde. Notes of the species occurring and their seasonal distribution.—Miss Frances M **Ballantyne**: The continuity of the vertebral nervous system: Studies on *Lepidosiren paradoxa* Numerous stages in the development of sensory nerve trunks (olfactory, auditory, spinal, lateral line), demonstrate that each trunk develops out of a protoplasmic bridge joining end organ and central nervous system at an early period of development while they are still in close proximity. The relations between neurofibrils and ganglion cells was dealt with and evidence adduced in support of the view that there is no real discontinuity at the so-called synapse.—E B **Bailey**. Perthshire tectonics: Loch Tummel, Blair Atholl, and Glen Shee The stratigraphical sequence of the district shows only minor variations from that worked out by E. M Anderson at Schiehallion, farther west (Quart Journ. Geol Soc., 1923) One of the main stratigraphical divisions, the Perthshire Quartzite Series, is disposed in three distinct recumbent fold-limbs of great cross-strike extent Of these, the Cairnwell Limb is top, the Tummel Limb is middle, and the Ben y Cloe Limb is bottom Important slides have been developed, more particularly in connexion with the Tummel Limb Subsequent recumbent folding has greatly affected the Tummel Limb and digitations of the Cairnwell Limb

PARIS

Academy of Sciences, May 4.—The president announced the death of M. Albin Haller.—E. **Goursat**. Some partial differential equations of the theory of deformation of surfaces.—G. **Bigourdan**. The equations, of various origins, which may affect the pendulum corrections employed at the Bureau International de l'Heure (B.I.H.) during the five years 1920–1925 The corrections are affected by various errors due to different causes; five years' observations are discussed and an attempt is made to separate some of these causes of error.—Nicolas **Kryloff**: The estimation of the error made in the application of the method of W. Ritz for the approximate integration of differential equations.—N. **Lusin**: A problem of M Émile Borel and the projective ensembles of M. Henri Lebesgue; analytical ensembles.—V. **Romanovsky**: The distribution of the mean square errors in observations on quantities

with normal distribution.—R. **Dugas**: The theory of fine structure and the principle of the equality of action and reaction.—L. **Escande** and M. **Ricaud**: The similitude of viscous fluids. Comparative experiments made with water and three oils of different viscosity. Reynolds's law held exactly, and the simultaneous application of the law of Reynolds and that of Reech showed that, giving to the homologous dimensions of two models a ratio equal to the ratio of the kinematic viscosity coefficients raised to the power 2/3, similitude was realised.—Henri **Abraham** and René **Planiol**: Magnetic sesquioxide of iron. Ordinary ferric oxide (colcothar) is not ferromagnetic. If a non-magnetic ferric oxide is reduced at 500° C. in hydrogen or in carbon monoxide, the reaction stops at about the stage of magnetite. This finely divided magnetite is not pyrophoric but is readily oxidised. If heated in air it burns like tinder and gives a non-magnetic red oxide; but if heated in a current of air at 200-250° C., oxidation is produced slowly and without incandescence. The resulting oxide is brown, has the same chemical composition as ordinary red ferric oxide, but is strongly ferromagnetic. Heated to 700° C. it is transformed into the non-magnetic red oxide.—Jean Jacques **Trillat**: Study of the fatty acids and the dicarboxylic acids by means of the X-rays. A slight alteration in technique, namely, dissolving the acid in alcohol, pouring some drops of the solution on a glass plate and allowing to evaporate, gives better results than the original method of pouring the melted acid on the plate. The thin layer behaves as a single crystal, and the X-ray spectrum shows only the fine lines corresponding to the length of the chain. Data are given for six fatty acids and four dibasic acids. The method can be applied in analysis, and will distinguish between a C_{17} acid and a mixture of C_{16} and C_{18} acids.—Salomon **Rosenblum**: A new determination of the ratio of the velocities of the two groups of α rays emitted by the active deposit of thorium. The ratio of the velocities of the α rays of thorium (C and C^1) is found to be 1·209, with a possible error of 0·1 per cent.—Th. De **Donder**: Affinity.—A. **Boutaric** and Mlle G. **Perreau**: The quantitative study of the protection realised in a colloidal solution by the introduction of an electrolyte in a quantity too small to produce flocculation. Studies of colloidal suspensions of gamboge and sulphide of arsenic. The results are given in the form of curves.—Léon **Guillet**: The thermal treatment of certain nickel brasses.—Fred **Vlès** and Mlle Madeleine **Gex**: The ultra-violet absorption as a function of P_H of some organic acids considered as ultra-violet indicators.—E. E. **Blaise** and Mlle M. **Montagne**: The preparation of the acyclic δ-diketones. By the condensation of ethyl magnesium bromide with the tetrethyldiamide of glutaric acid, the δ-diketone dipropionylpropane has been shown in an earlier communication to be one of the reaction products. It is now shown that the diethylamide of γ-propionylbutyric acid and a ketone of the constitution $C_2H_5 . CO . (CH_2)_2 . C(C_2H_5)_2 . N(C_2H_5)_2$ are also produced in this reaction.— — **Lespieau** and Charles **Prevost**. The hexabromide of diacetylene. The addition of bromine to diacetylene gives a hexabromide identical with that obtained by Noyes from the gas obtained by treating slightly oxidised copper acetylide with acid. From the hexabromide the diacetylene is easily regenerated by the action of zinc powder and alcohol.—Marcel **Sommelet**: The synthetic preparation of the homologues of benzyl chloride. The synthesis is based on the interaction of monochlormethyl ether and an aromatic hydrocarbon in the presence of stannic chloride as condensing agent.—R. **Lantz** and A. **Wahl**: The 1-arylamino-2-naphthoquinones.—L. **Cayeux**: The relative age of the silex and dolomites in the chalk of the Paris basin.—Louis **Besson**: The pluvial capacity of the equatorial current. The periodic factor of climate.—E. **Demoussy**: The changes in concentration brought about by diffusion.—St. **Jonesco**: The combined action of hydrochloric acid and metallic sodium on the reddening of a flavone extracted from the red leaves of *Prunus Pissardi*. The flavone, resembling quercitine in its behaviour to solvents, is attacked by metallic sodium, and the product of this reaction on treating with hydrochloric acid gives a red pigment. The latter does not appear to be a simple reduction product of the flavone, since other reducing agents do not produce the colouring matter.—Auguste **Lumière** and Henri **Couturier**: The ant-icoagulating action of zinc salts. Sulphate of zinc, in a concentration of 1 in 2000, completely prevents the coagulation of blood *in vitro*. Injection of the same salt into the living animal also has the effect of reducing the coagulability of the blood.—Mme. **Randoin** and E. **Lelesz**: Comparative variations of arterial glycæmia (effective and proteidic) and of the proportion of liver glycogen in the normal pigeon and in the pigeon submitted to a diet lacking in the water-soluble factor B. A deficiency of factor B does not prevent addition of the glycogen reserve nor does it prevent the sugar being set free in the blood, but the animal is deprived of a substance which is directly or indirectly indispensable to the combustion of the sugar.—P. H. **Fischer**: The rôle of the purple-producing gland of Murex and Purpura.—P. Cappe de **Baillon**: Double monsters in the phasmids.—L. **Fage** and R. **Legendre**: Swarms of *Scalibregma inflatum* observed while fishing with artificial light.

May 11.—Mlle. Madeleine **Marquis**, Pierre **Urbain**, and G. **Urbain**: The treatment of malacon. The separation of celtium from zirconium. Solution is effected by treatment with sulphuric acid followed by potassium bisulphate fusion; the zirconium and celtium are precipitated as double sulphate by addition of solid potassium sulphate. An account is given of various methods tried for the separation of these two elements. Fractional precipitation with saturated solutions of sodium carbonate has been found to give the best separation.—Gabriel **Bertrand** and M. **Machebœuf**: The presence of nickel and cobalt in animals. It has been shown that nickel and cobalt are widely distributed in arable earth and are also present in plants; nickel has now been proved to be present in animal tissues. In man and the higher animals the highest proportion of nickel is present in the liver. The amounts are extremely small, ranging from 0·004 milligram of nickel per kilogram of cow's milk to 0·455 milligram per kilogram in molluscs.—Paul **Mentré**: The projective properties of congruences, non W, with non-special complex linear osculator.—André **Roussel**: Semi-continuity and direct search for certain minima.—E. **Henriot** and E. **Huguenard**: The realisation of very high speeds of rotation. In the apparatus described the rotating body is not in contact with any liquid or solid and is free to take up its own axis of rotation. The rotor is supported and rotated by a current of compressed air; one model has maintained a constant velocity of 4000 turns per second for several hours.—P. **Dumanois**: The utilisation of anti-knocking compounds. A mixture of equal parts of petrol and kerosene with the addition of 1·5 parts per 1000 of lead tetraethyl gave good results in an internal combustion motor; there was no knocking, and the

consumption was the same as when pure petrol was used.—R. **Forrer**: An artificial magnetic anisotropy of nickel. The attainment of a state with a particularly simple cycle.—Josef Mikulas **Mohr**: The pole effect of the barium and neodymium lines in the visible part of the spectrum. The differences in wave-length due to the pole effect were studied in the interference spectrograph of Perot, one light bundle being taken from one of the poles and the other from the centre of the arc. The differences of wave-length negative pole minus centre and positive pole minus centre are given in tabular form for the chief lines of barium and neodymium.—Mme. J. S. **Lattès**: A method of analysis by absorption of radioactive radiations. A general method is developed capable of being applied to the analysis of any radiation, however complex.—J. **d'Espine**. The magnetic spectrum of β rays of great velocity of radium-B + C Measurements are given for 13 β rays of radium-B + C. The values of $H\rho$ are tabulated against the results of Ellis, Rutherford and Robinson, and Danysz, and are in good agreement with those of Ellis.—Louis Jacques **Simon**: Comparative chromic acid oxidation and molecular structure; tariric and stearolic derivatives.—Raymond **Delaby** and Georges **Morel**: The methylalkylglycerols. Notwithstanding the number of transformations involved, the best method of preparing the methylalkylglycerols is through the dibromhydrin, the stages being vinylalkylcarbinol, addition of bromine forming the dibromhydrin, conversion of the latter into the diacetin, from which the glycerol is obtained by the action of aqueous potassium carbonate.—Albert **Baldit**: Magnetic measurements in the centre and east of France.—Ernest **Esclangon**: Zones of silence by reflection on the surfaces of atmospheric discontinuities.—**Barré** and **Schnell**: The propagation of sound waves in the soil. Two velocities for sound in the soil were found: 2000 and 8500 metres per second. The higher velocity was found by observers on granite, the mine being also buried in contact with rock, whilst in experiments giving a velocity of 2000 metres the observer and the mine were both on sand.—René **Souèges**: The embryogeny of the Lythraceæ. The development of the embryo in *Lythrum Salicaria*.—C. **Charaux**: Datiscine, the glucoside of *Datisca cannabina*. Datiscine has the formula $C_{27}H_{30}O_{15}$, and crystallises with four molecules of water. Hydrolysed with acids, it gives equal molecules of datiscetine, glucose, and rhamnose, but on hydrolysis with a ferment it gives datiscetine and rutinose.—Marc **Bridel**: Primeverose, primeverosides, and primeverosidase.—Raymond **Hamet**: The medullary cribo-vascular formations of two Crassulaxeæ.—Lucien **Daniel**: New researches on heredity in the grafted Jerusalem artichoke.—A. **Maige**: Various methods of appreciation of the limiting level of amylogenous condensation.—A. **Němec** and K. **Kvapil**: The presence of nitrates in forest soils. Determinations of nitrate in soils of various ages under fir, pine, beech, oak, ash, and hornbeam.—F. **Couturier** and S. **Perraud**: Some properties of urea in contact with soils.—Adrien **Auguet** and Albert **Bruno**: The persistence of dicyandiamide nitrogen in a moulded calcium cyanamide, after remaining several months in the soil.—H. **Labbé** and B. **Théodoresco**: The action of insulin on the nitrogen metabolism. In a normal dog, injections of insulin are followed by an increase in the amounts of nitrogen excreted; the effect often persists several days after the injection.—Armand **Dehorne**: Observations on the biology of *Nereis diversicolor*.—**Goris** and M. **Metin**: The alteration of solutions of aconitine on keeping. On keeping aqueous solutions of aconitine nitrate there is a steady loss of toxicity; the decrease is very regular, and is proportional to the time.

CALCUTTA.

Asiatic Society of Bengal, April 1.—Hem Chandra **Das-Gupta**: On the occurrence of *Scylla Serrata* Forskal in the upper Tertiary beds of Hathab, Bhavanagar (Kathiawar). Fossilised specimens of the common edible crab of India have been known since 1767, but precise data regarding the locality and the age of the beds have been wanting. The sternal portion of such a fossil crab obtained from Hathab, Bhavanagar State, has been found in Miocene beds.—Kalipada **Biswas**. Sub-aerial Algæ of Berkuda Island. The Algæ occurred on the soil, on roofs, and on walls. Nine species are described, of which four are reported for the first time from India, and one—*Gomphosphæria aponina*, var. *muralis-Biswas*—is a new variety.—D. **Majumder**: Some characteristics of Kolarian songs. The songs are classed under four groups: (1) General; (2) love-songs; (3) moral songs, addressed to boys or girls; (4) miscellaneous (domestic affairs, food, etc.).—D. **Majumder**: On the terminology of relationship of the Hos of Kolhan. There are mainly two systems of kinship terms. One is applied to groups, the other to individuals. The latter system is of rare occurrence.—Braja Lal **Mukherjee**: The word "vrā" in the Rig Veda. The word "vrā" means hunter, and does not mean troop or host.—J. J. **Modi**. A note on the custom of the interchange of dress between males and females.

VIENNA

Academy of Sciences, March 12.—A. F. **Sonnenschein**. The homing of featherless bees; a contribution to the sense of orientation in the honey-bee. Bees whose antennæ have been amputated find their hive and its entrance in much the same way as normal bees, the sense of smell does not seem essential for their return home.—M. **Kohn** and S. **Grün**: Bromo- and bromo-nitro-ether of pyrogallol (xii.). Communication on bromo-phenols.—M. **Kohn** and M. **Heller**: On the interchangeability of halogen atoms and of nitro groups in some nitro-halogen-phenol-ethers (xiii.). Communication on bromo-phenols.—M. **Kohn** and A. **Rosenfeld**: (1) New observations on halogen phenols (xiv.). Communication on bromo-phenols. (2) A contribution to the knowledge of the pseudo-phenols (xv.). Communication on bromo-phenols.—J. **Weissenberger**, F. **Schuster**, and R. **Henke**: On the molecular compounds of the phenols, the localisation of the field of force of the residual valency. On organic molecular compounds, the group CCl_3.

March 19.—R. **Schumann**: A contribution to the subterranean tectonic of the Vienna basin.—E. **Heinricher**: Cattle-grazing, a factor contributing to change of form and formation of species in plants. *Centaurea jacea*, var. *pygmæa*, an example.—K. **Horovitz** and J. **Zimmermann**: Investigations on the exchange of ions in glasses.—J. **Zimmermann** and J. **Schneider**: Characters of glasses in terms of their electromotive properties.—J. **Schaffer**: On extensible elastic sinews in skeletal muscles. The limits of elasticity are considered, also the case of a Paraguayan marsupial which hangs for hours by its tail from branches.—H. **Handel-Mazzetti**. New Chinese plants (xxxiii.).—The late G. von **Niessl**: Catalogue of data for determining the paths of 611 great meteors.—A. **Aigner**: The formation of valleys on the southern edge of the Lower Tauern.—A. **Friedrich** and J. **Diwald**: On the lignin of pine-wood.

Official Publications Received.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 20, Part 14: The American Species of Cannaceæ and Wenderothia. By C. V. Piper. Pp. viii+555-588. (Washington: Government Printing Office) 10 cents.

Royal Botanic Gardens, Kew. Orchids (*Orchidaceæ*), Set 3. 6 post cards in colour with descriptive Folder. (Kew: Royal Botanic Gardens.) 1s.

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 1, No. 11: The Modes of Vibration of a stretched Membrane with a particular Law of Density. By Dr E. L. Ince. Pp. 102-116. 1s. 6d. Vol. 45, Part 1, No. 12. A Survey of Clyde Plankton. By Sheina M. Marshall. Pp. 117-141. 2s. Vol. 45, Part 1, No. 13: The Relation of Sea-Growth and Spawning Frequency in *Salmo salar*. By W. L. Calderwood. Pp. 142-148. 9d. Vol. 45, Part 1, No. 14. The Minimum System of Two Quadratic Forms in n Variables. By Prof. H. W. Turnbull and J. Williamson. Pp. 149-165. 1s. 6d. Vol. 45, Part 1, No. 15: The Law of Blackening of the Photographic Plate at Low Densities. By E. A. Baker. Pp. 166-186. 2s. Vol. 45, Part 1, No. 16. The Theory of Compound Determinants from 1900 to 1920. By Sir Thomas Muir. Pp. 187-212. 2s. 6d. Vol. 45, Part 2, No. 17. Discontinuities in the Atmosphere. By A. H. R. Goldie. Pp. 213-229+4 plates. 2s. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

University College of Wales, Aberystwyth. Welsh Plant Breeding Station. Studies concerning the Pollination, Fertilization, and Breeding of Red Clover. By R. D. Williams. (Series H, No. 4, Sessions 1921-24.) Pp. 58. (Aberystwyth.) 3s. 6d.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 31. The Permian Fish *Dorypterus*. By E. Leonard Gill. Pp. 643-661. (Edinburgh: R. Grant and Son, London: Williams and Norgate, Ltd.) 2s. 6d.

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1922-23. Vol. 1. Area, Classification of Area, Area under Irrigation, Area under Crops, Live Stock, and Land Revenue Assessment, and Harvest Prices in British India. Pp. ix+81+10 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 4d.

Bulletin of the National Research Council. Vol. 10, Part 2, No. 53: Honors Courses in American Colleges and Universities. By Frank Aydelotte. Second edition, revised. Pp. 96. (Washington, D.C.: National Academy of Sciences.) 1 dollar.

Safety in Mines Research Board. Paper No. 7. Second Report of the Explosives in Mines Research Committee, 1924. Pp. 10. (London: H.M. Stationery Office.) 3d. net.

Medical Research Council. Fifth Annual Report of the Industrial Fatigue Research Board to 31st December 1924 (including Personal Contributions from Investigators). Pp. 76. (London: H.M. Stationery Office.) 1s. 9d. net.

Leeds University. Department of Pathology and Bacteriology. Annual Report. By Prof. Matthew J. Stewart and Prof. J. W. McLeod. Pp. 15. (Leeds.)

Bulletin of the American Museum of Natural History. Vol. 52, Art. 1. Scientific Results of the Expedition to the Gulf of California in charge of C. H. Townsend, by the U.S. Fisheries Steamship *Albatross* in 1911. 14. Deep Sea Fishes of the *Albatross* Lower California Expedition. By Charles H. Townsend and John T. Nichols. Pp. 20+4 plates. (New York.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 1. Månadsöversikt av väderlek och vattentillgång jämte anstaltens årsberättelse. Pp. 101. (Stockholm.) 2.50 kr.

Recueil des travaux chimiques des Pays-Bas. Publié par la Société Chimique Néerlandaise. Tome 44 (4e Serie, T. 6), No. 5, Mai. Numéro jubilaire en l'honneur du Professeur Bohuslav Brauner, publié par ses amis et élèves en commémoration de son 70e anniversaire, 1855-8 Mai-1925. Pp. 281-628. (Amsterdam: S. A. d'Éditions scientifiques D. B. Centen.)

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Department of the Interior: United States Geological Survey. Bulletin 755. Mineral Resources of Alaska. Report on Progress of Investigations in 1922. By A. H. Brooks and others. Pp. 11+212+xv+12 plates. 40 cents. Bulletin 764: Phosphate Deposits in the Wind River Mountains, near Lander, Wyoming. By D. Dale Condit. Pp. v+39+3 plates. 15 cents. Bulletin 770: The Data of Geochemistry. By Frank Wigglesworth Clarke. Fifth edition. Pp. 841. 1 dollar. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, JUNE 13.

MINING INSTITUTE OF SCOTLAND (at St. Margaret's Hall, Dunfermline), at 3.30.—General Meeting.

PHYSIOLOGICAL SOCIETY (at Manchester).

MONDAY, JUNE 15.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. Alfred T. Schofield: The Capture of the Unconscious (Annual Address).

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. F. Buzzard: Charcot and the Centenary Celebration of his Birth.

TUESDAY, JUNE 16.

INSTITUTION OF MINING ENGINEERS (at South Wales Institute of Engineers, Cardiff), at 11 A.M.—Sir John Cadman: Petroleum Refining in South Wales.—Dr. J. S. Haldane: The Maximum Efficiency of Heat Engines and the Future of Coal and Steam as Motive Agents.—The Shutting Off of Gob-Fires in Gassy Seams (Memorandum by the Gob-Fires Committee of the Institution).—J. I. Graham and Dr. T. D. Jones: Spontaneous Combustion in the South Wales Coalfield.—J. H. Cookburn: The Principles and Operation of the Mines (Working Facilities and Support) Acts, 1923, Part I.

ROYAL INSTITUTION OF GREAT BRITAIN (jointly with Chemical Society, Society of Chemical Industry, and Association of British Chemical Manufacturers) (at Royal Institution), at 11 A.M.—Celebration of the Discovery by Michael Faraday of Benzene.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (III.).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—G. F. Shirras: Taxable Capacity and the Burden of Taxation and Public Debt.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Dr. A. Hutchinson: (*a*) The Use of Alignment Charts in Crystal Optics; (*b*) The Use of the Stereographic Protractor for the Interpretation of Laue Crystal Photographs.—H. E. Buckley and W. S. Vernon: The Crystal-structures of the Sulphides of Mercury.—Dr. E. Spencer: Albite and other Anthigenic Minerals in Limestone from Bengal.—Dr. R. Campbell and J. W. Lunn: Chlorophæite in the Dolerites (Tholeiites) of Dalmahoy and Kaimes Hill, Edinburgh.—Dr. L. J. Spencer: Tenth List of New Mineral Names; with an Index of Authors.

WEDNESDAY, JUNE 17.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 4.30.—Mrs. S. Stevenson: The Dheds.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark, I. D. Margary, and R. Marshall: Report on the Phenological Observations in the British Isles from December 1923 to November 1924.—D. N. Harrison and Dr. G. M. B. Dobson: Measurements of the Amount of Ozone in the Upper Atmosphere.—J. Baxendell: Meteorological Periodicities of the Order of a Few Years, and their Local Investigation; with Special Reference to the Term of 5·1 Years in Britain.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield).

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: Luminous Vapour from the Mercury Arc and the Progressive Changes in its Spectrum.—Prof. J. C. McLennan and A. B. McLay: On the Series Spectrum of Gold.—Prof. W. A. Bone, D. M. Newitt, and D. T. A. Townend: Gaseous Combustion at High Pressures, Part V.—W. T. David: The Effect of Infra-Red Radiation upon the Rate of Combustion of Inflammable Gaseous Mixtures.—R. K. Schofield and Dr. E. K. Rideal: The Kinetic Theory of Surface Films.—*To be read in title only*.—Prof. H. M. Macdonald: The Condition that the Ratio of the Intensities of the Transmitted and Reflected Electric Waves at the Interface between two Media is independent of their Plane of Polarisation.—Prof. C. V. Raman and L. A. Ramdas: The Scattering of Light by Liquid Boundaries and its Relation to Surface-Tension. Parts I. and II.—H. Weiss: The Application of X-rays to the Study of Alloys.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Hon. W. G. A. Ormsby-Gore: Some African Problems.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (IV.).

CHEMICAL SOCIETY, at 8.—H. Phillips: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXVII. Some Esters of *p*-toluene Sulphonic and Sulphinic Acids.—F. R. Goss and Dr. C. K. Ingold: The Enhanced Reactivity of Newly-formed Molecules. Part I. The Conversion of Cyclols into Ketones.—F. H. McDowall: Constituents of *Myoporum laetum* Forst. ("The Ngaio"). Part I.—J. Kalff and R. Robinson: A Synthesis of Datiscetin.—J. Allan, A. E. Oxford, R. Robinson, and J. C. Smith: The Relative Directive Powers of Groups of the Forms RO- and RR'N- in Aromatic Substitutions. Part IV. A Discussion of the Observations recorded in Parts I., II., and III.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.15.—Induction of Dr. A. Balfour as President.—Dr. G. C. Low: The Use of a Drug named "Smalarina" in the Treatment of Malaria.—Award of the Chalmers Medal to Prof. Warrington Yorke, who will read a paper on Further Observations on Malaria made during Treatment of General Paralysis.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY.—Summer Meeting in the Gloucester District (continued on June 19, 20).

SATURDAY, JUNE 20.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Summer Meeting) (at Birmingham University), at 10.45.—Business Meeting.—At 11.30.—Dr. Shakespear: Colour (Lecture).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (in Bio-chemical Laboratory, Cambridge), at 2.30.—Dr. Kay and Dr. Wines: Bone Formation and Experimental Rickets.—At 4.45.—Dr. J. F. Gaskell: The Relationship of Experimental Pneumonia in Rabbits to the Pneumonias of Childhood.

FREE PUBLIC LECTURE.

THURSDAY, JUNE 18.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Dr. R. Robison: The Chemistry of the Calcification of Bone.



SATURDAY, JUNE 20, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2903, VOL. 115]

The Amani Research Institute.

THE announcement made in the House of Commons on June 10 by the Hon. W. Ormsby-Gore, Under-Secretary of State for the Colonies, that early steps are to be taken for the establishment of the Amani Institute in Tanganyika Territory and for its upkeep as a centre of scientific agricultural research for the benefit, first, of the British East African dependencies, and secondly, of tropical economic development generally, is a very welcome one, for which we have long been waiting.

The Amani Institute was founded by Germany in 1902. The Institute is situated in the Eastern Usumbara Mountains, about thirty miles from the port of Tanga, and is approached by railway as far as Sigi or by a good motor road. The main buildings, including the laboratories and most of the residences, are situated in a group at a height of about 3000 feet. The Institute grounds comprise some 600 acres, 200 acres of which are under cultivation and the rest are virgin forest. As the mean annual temperature at Amani is 67·8° F. and the average rainfall is 55 inches, the climate is very pleasant; it is a healthy place and very free from mosquitoes. The buildings consist of several residences and very good and well-fitted chemical, botanical and zoological laboratories, together with a herbarium and library and the various garden buildings. A full description of the Institute has been given in the *Berichte uber Land- und Forstwirtschaft*, Band II., and in the *Jahresbericht des Biologischen Landwirtschaftlichen Instituts Amani* for the year ending March 1914. These records, with their accompanying plans, show that the Institute was designed on a scale more nearly appropriate to the needs of a territory, such as that it was intended to serve, than anything provided by the Government of a British Crown Colony.

The work carried out by the Institute while in German hands was of a very valuable character, for there was developed an admirable scientific establishment devoted to the intensive study of the problems connected with vegetable physiology, both on the nutritive and the genetic side, on the fungal and insect aspects of plant pathology, and also with regard to the chemistry of soils and of plants.

In establishing the Institute at Amani, Germany had created a research station comparable to the corresponding Institute at Pusa in India, to which India owes so much, and to the Institute at Buitenzorg in Java, which has so long served the Dutch East Indies as a central station for the study of the many problems in tropical agriculture in the East. Amani during its period of activity under German management showed that it was a worthy rival both of Pusa and Buitenzorg, and, had it been allowed to continue as it was begun, it would no doubt have been able to confer

benefits on eastern tropical Africa as great as those which already stand to the credit of the Indian and Javan establishments.

Ever since the Tanganyika Territory came into British hands, however, the Amani Institute has been in a very uncared-for condition. For the first few years a director was in charge of the establishment, but as he had no officers working under him his duties were rather those of a caretaker than a director, and it was not possible for scientific work of any value to be done there at all, especially as he had to see to the proper care of the valuable instruments, books and specimens in the laboratories. In addition to the Director there has been a head gardener or Curator, who has been responsible for the plantations and for all the gardening work. These two officers have been in sole charge of the Institute. Since the retirement of the Director, the Curator has been the only European at Amani; and it is satisfactory to know that he has maintained the Institute and the grounds, and has been given the necessary help to look after the herbarium collections.

Amani properly constituted would serve not only as a centre for research, but also would be a valuable place to which the scientific workers attached to the Departments of Agriculture could go in connexion with the various problems confronting them in the several departments, while research officers at Amani would be engaged in working out the problems brought to their notice by the agricultural officers throughout these Colonies.

Another point of great value in such a place as Amani would be that scientific workers from home and from other parts of the Empire would be able to work at the Institute on scientific problems, as was the case in the past, and in the same way that botanists and other scientific officers are now able to carry out their researches at Pusa or Buitenzorg.

The matter of the re-establishment of Amani has, we believe, been under consideration at the Colonial Office for some years, and it seems unfortunate that instead of taking direct action from home, the various Colonies have been consulted as to whether or not they considered Amani would be of any value to them. Amani should be essentially an Imperial rather than a local institution, and it should be so maintained and extended as to serve as an agricultural research institute for the conjoint benefit of all the British Colonies and Protectorates in East Africa. In order that the Institute should fulfil its functions in the best possible manner, it should be independent of the control of any Department of Agriculture in these Colonies and Protectorates.

The potential value of Amani to the East African dependencies is immense, and it is essential that the Institute should be placed on a proper basis with as little delay as possible.

The Protection of Wild Birds.

TWO years ago Viscount Grey of Fallodon introduced a Bill on this subject in the House of Lords, as was noticed in these pages at the time, but the measure did not succeed in becoming law before the dissolution. In the present Parliament a Bill has been introduced by the Home Secretary and at present awaits a second reading in the House of Commons. The new Bill closely resembles its predecessor, although the drafting and arrangement have been improved, and it likewise aims at giving effect to recommendations of the Departmental Committee which reported in 1919. It is intended to supersede all the existing legislation on its particular aspect of the subject, apart from the special Game Laws, and to secure uniformity, simplification, and greater effectiveness.

The Bill gives some general protection to all birds by the total prohibition of certain methods of destruction and capture involving obvious cruelty. Bird-catching is to be strictly regulated, and prohibited on Sundays throughout the year, and on highways and commons at all times. In addition, special protection is given to different species according to three categories into which all birds are for this purpose to be divided. Birds named in the first category, with their nests and eggs, are to be protected absolutely at all times. Birds named in the second category, with their nests and eggs, are to be protected absolutely during the close season. The third category comprises all other species; these, but not their nests and eggs, are to be protected during the close season except against the owner or occupier of the land and his agents. (The protection of nests is a useful innovation.) The general close season is from March 1 to August 11. The woodcock has a special close season from February 1 to August 31, and the nests and eggs of the lapwing are not protected against the owners and occupiers of the land before April 15.

The Home Secretary, and in Scotland the Secretary for Scotland, is to have power to vary the classification or the close season of any bird, either generally or locally. In particular, he has power to give the status of Category I. to all birds in any bird sanctuary; but he may make exceptions, which is a wise provision in view of the fact that the undue multiplication of a common aggressive species may be at the expense of the others which it is desired to protect. He may also grant exempting licences for scientific purposes. This is a useful provision, but care will be needed to discriminate between genuine investigators and the type of collector, especially of eggs, who levies special toll on rare species and does nothing to increase ornithological knowledge.

Permits are also to be necessary before any imported foreign bird may be released in Great Britain. The case of the little-owl has taught its lesson, for this alien has become a pest and a menace to other birds in some parts, and has also tended to discredit the native owls, which have in reality quite different habits. In the exercise of these various powers the Home Secretary and the Secretary for Scotland are to be aided by advisory committees. These bodies are already in existence, for their institution was a recommendation of the Departmental Committee which had not to await legislation.

The new Bill will introduce a welcome uniformity which is lacking under the present system whereby too much is left to the initiative of local authorities. In addition to administrative considerations, the migratory habits of very many species make it impossible to deal logically or effectively with questions of protection from a local point of view. Variations between one district and another have also brought the law into disrepute from its very complexity. In other ways, too, the new Bill is less cumbersome to administer and is simpler to understand.

Apart from simplification, the new Bill should be more effective than the present law. It increases penalties and the powers of the police. It also makes it easier to prove an offence. The onus is put on any person found in possession of illegally taken birds or eggs, and taxidermists are to keep registers of all specimens coming within the scope of Categories I. and II. Similarly, it will no longer be possible to expose "plover's" eggs for sale more than five days after the beginning of protection: an absurd anomaly will thereby be removed.

The new Bill is therefore greatly to be welcomed, and one may hope that with its official backing it may indeed come into operation on the date proposed, January 1, 1926. It may perhaps be criticised, however, on the ground that it does not go far enough. It is mainly uncommon birds that are listed in Categories I. and II., and there is not full protection for some of the common insectivorous species—for example, the swallow—which are universally admitted to be beneficial as well as beautiful. It may be answered that the law as a whole gains by avoiding the creation of too many offences, and in any event there will be power to add to the schedules without the difficulty of a fresh appeal to Parliament. The point may have importance when the question of international co-operation as regards migratory species again comes forward, as there is ground for hoping it will at an early date.

There are two general provisions which one misses from the Bill, although both were recommended by the Departmental Committee. It was proposed that the advisory committees were to conduct investigations into the economic status of various species, something corresponding to the Hungarian Institute of Ornithology or the U.S. Bureau of Biological Survey being contemplated; at present, it does not appear that the committees are to be given the necessary machinery for performing this function, and they are defined as being purely advisory. The Departmental Committee also stressed the necessity for providing watchers for bird sanctuaries, because an unguarded sanctuary becomes the obvious prey of collectors and pot-hunters and is therefore worse than useless. The cost of watchers at a few selected places would be trifling to the central or local authorities, but it is nevertheless a heavy burden upon the available voluntary sources of funds for this national work. A. L. T.

Egyptian Mathematics.[1]

The Rhind Mathematical Papyrus: British Museum 10057 and 10058. Introduction, Transcription, Translation, and Commentary by Prof. T. Eric Peet. Pp. iv+136+24 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 63*s.* net.

II.

AMONG the mathematical processes known to the Egyptians (for some few of which we have to go to the Berlin and Moscow papyri) were squaring and extraction of square roots, arithmetical progressions and simple geometrical progressions starting from unity, the solution of equations of the first degree, and a few simple cases of equations of the second degree. In geometry, or rather mensuration, they thoroughly understood the areas of square and rectangle; they knew pretty well how to deal with triangles, though precisely how much they knew is a more debatable matter; in a problem dealing with the truncated (isosceles) triangle, we recognise Hero's τραπέζιον ἰσοσκελές. They found the area of the circle by squaring $\frac{8}{9}$ of its diameter, a near approximation —giving $\pi = 3{\cdot}160$. . . . They knew the volume of the cube and rectangular parallelepipedon; they found the volume of a cylinder by multiplying its height into the area of its base; and one remarkable problem in the Moscow papyrus gives a correct solution for the frustum of a regular square pyramid. Their elaborate system of weights and measures Griffiths especially, and other writers, have sufficiently explained.

Towards the close of his admirable introductory chapter, Prof. Peet gives us a short but very interesting

[1] Continued from p. 902.

comparison between Egyptian mathematics and that of the pre-Semitic or Sumerian Babylonians. We know little or nothing of how this latter people worked their problems, for what they have left us consists of bare tables of multiplication and division, of squares, and of square and cube roots. But they were undoubtedly versed in elaborate calculations, and two points in their mathematical system stand out as of the highest interest In the first place they used a sexagesimal notation, in which lie the roots of many things, including the division of the hour into 60 minutes, and of the circle into 360 degrees (apparently a "smoothing" of the 365 days of the year), Euler was using a pure Sumerian notation when he went on from minutes and seconds to thirds (just as Ptolemy did), and even to quarts, quints and sexts The curious question arises whether this sexagesimal system was primitive, or was deliberately adopted for its convenience; and Prof. Peet, leaning to the latter view, shows that 10 remained a subordinate unit, and that even the numbers from six to ten are but derivatives of those from one to five The second point, marking a very high grade of mathematical insight, was the use of a "positional notation," closely comparable to that which we ourselves inherit from the Moors. Thus, just as we understand, when we write 365, that the 3 has to be multiplied by 10^2, etc, so the Sumerian could write 32 12 43, and mean or assume that the 32 was multiplied by 60^2, and the 12 by 60, the whole number was expressed as elegantly in his notation as we express it by 115,963 The singular thing, however, is the apparent mixing up here of a decimal with the sexagesimal system, for the 32 was, literally, thirty-two, *i.e.* it was expressed by three tens and two units the fact being that their notation had only two signs, a unit and a ten, and was in this respect no more advanced than the Egyptian.

Prof. Peet's short comparative sketch of Sumerian arithmetic contains many other curious things, into which we cannot follow him; it is a subject which becomes more interesting the more we know of it. On one of its by-paths we have Hilprecht's attempt to demonstrate that Plato's mystical "Number" has its roots in the old sexagesimal system, deep down in Sumerian arithmetic; it may fall short of convincing, as Prof. Peet declares, but it is very interesting indeed. The classical student may thank Prof Peet for his short but excellent epitome of what Herodotus, Strabo, Diodorus, and a few other Greeks have to say regarding Egyptian mathematics. *Inter alia*, he comes to the conclusion that the famous *harpedonaptae*, or rope-stretchers, were no more than land-measurers; in other words, that they used their rope just as our surveyors use their "chain."

We need not try to epitomise the range of problems which the Rhind papyrus contains, much less to summarise the indispensable comments and explanations which Prof. Peet gives. But it may whet the student's appetite, and send him all the quicker to the book itself, if we quote as briefly as possible one or two actual problems. Let us begin with one of the problems of "division of loaves," which are merely simple exercises in the use of fractions. "To divide nine loaves among ten men. You are to multiply $\frac{2}{3}+\frac{1}{5}+\frac{1}{30}$ by 10.

The doing as it occurs:

1	$\frac{2}{3}\cdot\frac{1}{5}\cdot\frac{1}{30}$
/ 2	$1\frac{2}{3}\cdot\frac{1}{10}\cdot\frac{1}{30}$
4	$3\frac{1}{2}\cdot\frac{1}{10}$
/ 8	$7\frac{1}{5}$

Total, 9 loaves There is it."

As so often happens the working is not given, but only the proof: how the share of each man, namely, $\frac{2}{3}+\frac{1}{5}+\frac{1}{10}$, is arrived at we are not told But evidently the Egyptian, dealing with $\frac{9}{10}$ (or rather with the idea of $\frac{9}{10}$), saw that he could handle it better, break it up more easily into aliquot parts, when in the form $\frac{27}{30}$, *i.e.* $\frac{20+6+1}{30}$ He evidently found 30 a convenient *mokhraj*, and he uses it again and again, for his 7, 8, and 9 loaves. When he proceeds to verify, by multiplying his result by 10, we see how skilfully he uses his fractions, retaining only the aliquot parts; in his first duplication he sees at once, or knows from his tables, that $\frac{2}{5}=\frac{1}{3}+\frac{1}{15}$, that $\frac{2}{30}=\frac{1}{15}$, and that $\frac{2}{15}=\frac{1}{10}+\frac{1}{30}$.

Note the curious phrase "the doing as it occurs." Prof. Peet goes to some pains to justify his rendering; but Baillet (from whom he differs) is not the only scholar who has seen in these words the plain "Do thus," *πολει οὕτως*, which Hero employs in a similar way, and which reappear once more in the late Greek of the Akhmim papyrus. Hero of Alexandria has a great place, and Diophantus of Alexandria has a greater, among Greek mathematicians; but they may both of them have been Egyptians after all. I have, by the way, my doubts (however little they may be worth) even of the great Archimedes—for Sicily has been time out of mind a meeting-place of many races of men. I once asked a learned Orientalist what he would make of the name Archimedes, were he told that it was an Arab name, with the "Al" before a rough breathing softened by corruption into *Ar*. Without a moment's hesitation he said "Al-Hamad, of course!" It would be strange indeed if Archimedes, as great a mathematician as ever lived, was just one of those learned Sicilian Maghrebim, such as long

afterwards are said to have taught Leonardo Pisano and Leonardo da Vinci himself.

"A quantity whose fourth part is added to it becomes 15." This is an example of what is commonly called the *hau*, or *heap*-calculus. The word *hau*, or *h'w*, Prof. Peet describes as "a mathematical-technical term equivalent to our 'quantity'"; he calls it a good example of the concrete nature of Egyptian mathematics. The Sanskrit arithmeticians use a precisely equivalent name; the Arabs called it by a word meaning "possession," or "sum [of money]," a meaning which survives in the "*avere*" of Leonardo. These arithmetical terms are curious and interesting in themselves; and all the more because they are separate and distinct from another series with kindred meaning, which arose afterwards, including the Arabic *shay*, "the thing," Italian *cosa*, German *die Coss*, etc.; these latter terms came in with algebra—"la règle de *la chose*," as they called it in the early sixteenth century.

Coming back to our problem, the Egyptian proceeds as follows: "Reckon with 4. you are to make their (*sic*) quarter, namely 1. total 5." Here, as Rodet points out, the process is precisely that enjoined in the medieval (Moorish) arithmetics: Look for the smallest number such that we can take of it the fractions required, in the form of known numbers; and add these fractions to the number itself. "Reckon with 5 to find 15 . . . the result is 3. Multiply 3 by 4, etc." The problem is thus dealt with as one of simple proportion. The word which Prof. Peet translates "reckon with" (*w:h, w:h tp*) has, by the way, been the subject of much discussion; Prof. Peet's rendering is at any rate on the safe side, and his explanation seems to be quite new.

"I go three times into the *hekat* (bushel); a third of me is added to me, a third of a third is added to me, and a ninth of me is added to me. I return fully satisfied. What is it that says this?" The fractions are added together, and the whole is shown to amount to $3\frac{1}{2}+\frac{1}{18}$; by this quantity, then, the 1 bushel has to be divided, or rather, in the first instance, the *unit* has to be divided. After the usual process of "dimidiation," $\frac{1}{4}+\frac{1}{8}\frac{1}{2}$ of the said amount are shown to sum up precisely to one; and it is then easily shown that, in one *bushel* of 320 *ro*, $\frac{1}{4}+\frac{1}{8}\frac{1}{2}$ is equivalent to 90 *ro*. The whole procedure is purely arithmetical; there is no *x*, there is no equation—there is no algebra.

A more difficult problem is: "A hundred loaves [in arithmetical proportion] to 5 men, one-seventh of the first three men to the two last. What is the difference of share?" The *regula falsi* is applied: we are told, that is to say, to give one loaf to the first man; but we are then told, or told to suppose, the common difference to be $5\frac{1}{2}$—which is the crux of the problem. Prof. Peet says that "the trial numbers chosen are not really arbitrary, but are chosen because they were already known to be suitable for the purpose." Be that as it may, the old arithmetician would soon discover the required progression by his usual method of trial and error; starting with one loaf as the first man's share, and trying successively common differences of one loaf, two loaves, etc., he would not be long of finding when the three lowest terms were just one-seventh of the two highest. It is no difficult matter for us, nor was it perhaps for him, to see that under these conditions the common difference is always $5\frac{1}{2}$ times the lowest term.

The following simple problem illustrates some notable features. "To divide 3 *setát* of land into 5 fields. You are to operate on 5 *setát* to find 3 *setát* of land." Observe that whereas *we* should divide 3 *setát* by 5, to find so many *setát* or parts thereof, the Egyptian divides 3 *setát* by 5 *setát*, obtaining a pure number. He is right and logical in doing so, because his whole method consists in comparing two series of *numbers*, and demonstrating the equivalence between them, namely:

1	5
/ $\frac{1}{2}$	$2\frac{1}{2}$
/ $\frac{1}{10}$	$\frac{1}{2}$.

Therefore, since $2\frac{1}{2}+\frac{1}{2}$ sum up to 3, so also do $\frac{1}{2}+\frac{1}{10}$ sum up to the fraction required. But in his proof, when he has to multiply that quantity by 5, he does not speak of $(\frac{1}{2}+\frac{1}{10})$ *setát*, for he knows that it is so much *land* which he is now multiplying, and he has no name or sign for $\frac{1}{10}$ *setát*, he has to translate his fraction at once into $\frac{1}{2}$ a *setát* plus 10 cubits of land. He has passed from pure number to land-measure, with its own appropriate notation or nomenclature.

The many more difficult problems, of mensuration of areas, volumes, etc, are too lengthy to be dealt with here; once more, we must refer the reader to Prof. Peet's book. Its value lies not only in the new matter which it contains, but in the clear and very readable account it gives of what we already knew; it will hold its own for many a day as the best account of Egyptian mathematics; it will add not a little to the high reputation which, as Craven fellow and Liverpool professor, as scholar, teacher and explorer, its author has already won. Prof. Peet has done all he claims to do, and from the Egyptologist's point of view his task is done; but I fancy that the historian of mathematics has still a vast deal to do in the *comparative* study of Egyptian and other early arithmetics.

D'ARCY W. THOMPSON.

Physiology for Zoologists.

Grundriss der vergleichenden Physiologie. Von Prof. W. von Buddenbrock. Erster Teil: *Sinnesorgane und Nervensystem.* Pp. iv+276. (Berlin: Gebrüder Borntraeger, 1924.) 14*s.*

THE first feeling of the reviewer in laying down this book by Freiherr W. v. Buddenbrock, professor of zoology at Kiel, is one of regret that it is not written in the English language so as to be more freely accessible to our university students of zoology. The publication of this comparatively elementary text-book may be taken as symptomatic of the growing appreciation on the part of zoological teachers of the importance of the physiological side of their subject.

The habit, widespread during the past few decades, of exponents of the morphological and the physiological sides of the study of living creatures to ignore one another, has had deplorable results in slowing down progress by limiting that breadth of vision upon which all great advances depend. The book under review is not alone in suggesting that the end of this unfortunate period is at hand, and that it will be succeeded by one in which the new generation of zoologists will realise fully the importance of combining morphology and physiology together in fertile union. A phrase in the author's preface suggests a possible danger which will have to be guarded against. As he correctly states, the present movement of zoology towards the physiological side is "a sound reaction" against the prevalent narrow morphology: the need will be to control this reaction and prevent it from going so far as merely to replace a relatively sterile morphological training by an equally sterile physiological.

The present volume, constituting the first part of Freiherr v. Buddenbrock's text-book, is devoted to the nervous system and is divided into two main sections, the first dealing with the senses and the second dealing with the physiology of the nervous system apart from sensation.

In the first of these the subject matter is treated according to the nature of the stimulus with which the particular sensation has to do—under such headings as "Light sense," "Mechanical sense," "Chemical sense," "Temperature sense"—each heading being in turn divided up under convenient sub-headings. Thus under the main heading "Light sense" we have special sections dealing with shadow-reflex, photokinetic reaction, effect of light upon the tonic contraction of muscles, effect on direction of movement, conditioning factors of phototactic movements, stationary orientation towards light, "compass" movement, appreciation of form, the eye as a piece of physical apparatus, accessory arrangements of the eye, colour sense, black as a sensation.

Under the heading "Mechanical sense" the author deals with touch, with the activities of such organs as the halteres of dipterous flies and the sensory tentacles of jelly-fish (concerned not with the setting free of definite reflex movements, but rather with the control of the ordinary movements of the body), with the sense of movement and the sense of position, the special activities of otocysts or statocysts in this connexion, and the sense of hearing.

"Chemical sense" is dealt with under the headings smell and taste. Reference is made to the interesting work by Matthes upon the power of sniffing, *i.e.* drawing a current of the external medium through the olfactory organ, but it should have been mentioned that this faculty makes its appearance for the first time in the vertebrate series, not in urodele amphibians, but within the group of fishes. The fact that Lepidosiren possesses this power was observed nearly thirty years ago, and the description given in the text of the behaviour of newts sniffing at pieces of earthworm under water is textually accurate for the behaviour of young Lepidosirens in similar circumstances. The manner in which the mechanism for sniffing has originated in evolution is also clearly indicated by one of the Dipnoi, namely, Protopterus, in its ontogenetic development.

The second half of the volume opens with a short résumé of the general physiology of the nervous system, and this is followed by a sketch of what is known regarding the special physiology of the more important groups of invertebrates—Cœlenterata, Echinodermata, Annelida, Arthropoda, and Mollusca. In each case the treatment is just what is wanted by the student of zoology—only such matters being gone into as appear to the author to be, in the present state of knowledge, of real importance. The student's interest is not smothered and his breadth of vision obscured by masses of detail.

This special part ends with a short section on Vertebrata, in which are brought out the more important points in which this group differs from the invertebrate groups already dealt with.

Differing as it does from preceding text-books on comparative physiology, Buddenbrock's book is, to a certain extent, a pioneer work. Misprints and slips in detail are comparatively few for a work of this character. The book is illustrated by simple, well-chosen figures. The treatment, and a good deal of the substance, is original.

While dotted about the pages of the book occur the names of investigators to whom we owe particular bits of knowledge, there is no attempt made to trace the historical development of the various parts of the

subject, nor are there given any references to literature. Some may count these omissions as serious faults, but to the present reviewer they serve to awaken distant memories of dry-as-dust lectures, consisting of critical digests of the work of successive investigators, which were particularly effective in killing interest, and he cannot but think Buddenbrock's method the better one. There are doubtless others who believe with him that modern biology has suffered much from its overwhelming literature. The easiest of all types of advanced teaching is that which consists of a series of excerpts from literature with more or less critical remarks attached, but it breeds a timorous, relatively sterile type of biologist who will either content himself with being a mere abstracter of other people's work or, if he takes up original research, will seldom achieve more than the mere addition of more detail to that already existing. Buddenbrock's book will leave its reader with the knowledge that comparative physiology is a real and live, if a young, science: it is one which, in the reviewer's opinion, should be read by all university students of advanced zoology.

Yorkshire.

Geology of Yorkshire: an Illustration of the Evolution of Northern England. By Prof. P. F. Kendall and Herbert E. Wroot 2 vols. Pp. xxii+995+72 plates. (Leeds: Prof. Kendall, Moor Allerton; or H. E. Wroot, 99 Spencer Place, 1924.) 17*s.* 6*d.* net

DIVERSIFIED beyond compare among counties, both in its surface features and in the range and exposure of its outcropping formations, Yorkshire has naturally given rise to a copious stream of geological literature, which has flowed unceasingly ever since the establishment of stratigraphical studies within it more than a century ago The depth and strength of the current can be gauged well from this latest work, which is in all respects a powerful addition to the stream, with novel and serviceable attributes.

By a happy combination of thorough geological knowledge with skilful literary art, the authors have contrived to produce a work which, while helpful to the trained geologist, will appeal strongly to the much wider circle who, without high technical qualifications, desire to gain some understanding of the building and shaping of their county. While instructive about every formation in Yorkshire, it does not aim at giving a circumstantial account of the stratigraphy, but concentrates mainly upon the parts which have been particular objects of the senior author's researches, thereby introducing a touch of polemic which gives a spice wanting from impersonal compilations, however full and balanced. In the preface the authors plead for a free use of the imagination in order to lure recruits to the science; and their plea has much in its favour, always provided that the recruits do not follow suit too quickly, as they are rather apt to do.

Among the subjects thus accentuated are the reef-knolls and the underground drainage-channels of the Carboniferous Limestone country; the "wash-outs" of the Coal Measures; the growth-in-place origin of coal; the "cleat" in coal; the deltaic character of the Millstone Grit; the "brockram" of the Permian and other evidence for desert conditions in the rocks; the life-history of the fossil cephalopods; the components of the chalk; the development of the river-system; the Pleistocene glaciation, with special reference to the overflow channels and other evidence for glacial lakes; and various matters of economic interest

The authors state their opinions, not "dogmatically as Articles of Faith, but as working hypotheses for the reader's own confirmation or rejection in face of the phenomena," and with this attitude they will doubtless welcome the criticism likely to be aroused at points which we have not space to specify.

The technical matter of the work is pleasantly relieved by anecdotal and personal touches, and by biographical sketches, with portraits, of most of the past workers in Yorkshire geology; so that the reader is provided with the history, as well as with the interpretation, of the stratigraphy. The work is divided into three parts: the first (655 pp) being the main text, to which we have just referred; the second (70 pp.), a description of the geological sections and features to be observed along the principal railways; and the third (230 pp.), "Specimen days in Yorkshire," intended as a guide to a series of geological excursions covering every part of the county. In the last two parts the local descriptions serve to amplify and systematise the stratigraphical account in the main text, so that in one part or another the student is provided with a fairly full account of every formation. Fully illustrated with well-chosen and well-printed plates and text-figures, many reproducing the artistic geological photographs which we owe to the ripe judgment and skill of Mr. Godfrey Bingley, the work, beside its scientific consequence, cannot fail to arouse pleasurable memories in any one who has ever felt the spell of the Yorkshire scenery.

In these days of dear printing, the cheapness of the work is amazing, but is explained by the authors in the preface. Failing to find an amenable publisher or practicable terms for printing at home, they have had the printing done in Vienna, and are themselves the publishers and distributors.

The result has justified the experiment, as the typing is excellent and the misprints few and un-

important. The copy before us is bound as a single volume, but we understand that the work is now bound in two volumes and will be supplied in this form only, which is certainly the better way in view of the intent that Parts II. and III. are to serve as a local guide-book. For such a purpose the single volume is decidedly too bulky

As a point of minor criticism, we may note that the dual authorship is curiously exemplified by the numerous instances in which the senior author is referred to by name or in the third person, a construction which unnecessarily accentuates the duality.

G. W LAMPLUGH.

The Falkland Islands.

The Falkland Islands By V F. Boyson. With Notes on the Natural History, by Rupert Vallentin. Pp. 414+24 plates. (Oxford. Clarendon Press; London: Oxford University Press, 1924) 15*s* net.

EARLY in the sixteenth century a group of islands to the east of Patagonia began to appear on charts It is not clear who first sighted them, but Miss Boyson is inclined to give the honour to Amerigo Vespucci and to identify with the Falkland Islands the land which the Florentine astronomer claimed to have discovered in 1502. In any case, the history of the Falklands did not begin until the voyage of Cavendish and Davis in 1592. From then until the battle of the Falklands, Miss Boyson traces the varied history of the islands and the adventures of rival whalers and settlers which led to the curious claim of the Argentine to the sovereignty of the group, a claim that was maintained long after they had become a British colony inhabited entirely by British settlers.

From a scientific point of view, the second half of the book is of most interest in its full treatment of the cattle and sheep-farming and of the sealing and whaling in Falkland waters. To these chapters are added others on the climate and natural history. The cattle introduced by the early settlers eventually ran wild, but were gradually exterminated as sheep became the chief interest of the settlers. This occupation also led to the extermination of the Falkland Islands fox, which was said, with good reason, to attack and kill sheep. Whaling has now left the islands for the dependencies, and fur-sealing for many years has been prohibited on Falkland coasts in an attempt to preserve the few remaining fur seals, but in the past both occupations largely influenced the history of the islands.

The chapters on natural history are by Mr. R. Vallentin and are based on his own work and collections with some, but not complete, references to other workers in this field. The chapters on climate, stone rivers, and flora are, however, apparently by Miss Boyson. The remarkable stone rivers were originally attributed to volcanic action but now are generally explained by a downward creeping movement of water-logged soil, a process of solifluction during the ice age when the climate was not cold enough to allow glaciers to form but permitted a thick snow covering in winter. Miss Boyson scarcely touches on the problem of the former connexion of the Falklands with the arc of folding connecting South America with Graham Land. A problem of interest which she discusses is the so-called forest bed of coniferous tree-trunks discovered at West Point Island some years ago. Opinion now inclines to the belief that it is built of driftwood. If it is not, it certainly points to a change of climate in quaternary times. The volume is beautifully illustrated and provided with a good map. The historical part in particular is well documented. Altogether it is a work of great value and fills a distinct gap among authoritative works on the British Empire.

Our Bookshelf.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie. Band 1: Die Plastiden. Von Dr Paul N. Schürhoff. Pp. iv+224. (Berlin: Gebrüder Borntraeger, 1924.) 14*s*. 9*d*.

THE volume under notice is one of a series on plant anatomy and cytology. Plastids are probably the most characteristic bodies in plant, as contrasted with animal, cells. As a compilation of nearly all that is known concerning the structure and physiology of plastids, this work will fill a useful place. The extent of the literature bearing on the subject may be judged from the literature list of more than 700 titles. The great range of plastid form and structure is considered for the different groups of plants, including leucoplasts and elaioplasts as well as the various forms of chromatophores. Under the heading "Constituents of Plastids" the chemical composition of chlorophyll and other pigments, such as fucoxanthin and the carotinoids, is briefly considered. The physiology of chloroplast movement and of greening are discussed, as well as such subjects as "complementary chromatic adaptation." Carbon assimilation, which has its seat in the chloroplasts, is considered at length as a process, and also in relation to the internal physiology and the external environment (light, temperature, and carbon dioxide content) of the plant.

In the final section on the "pathology of plastids" the phenomena of chlorosis, mottling, chimæras and similar topics are included. In this connexion not only the histological structure but also the hereditary behaviour is discussed. The relation of plastids to mitochondria is also considered in another part, but there is no allusion to the important work of Lindstrom and others on the inheritance of plastid differences in varieties of maize.

R. R. G.

Shaman, Saiva and Sufi: a Study of the Evolution of Malay Magic. By Dr. R. O. Winstedt. Pp. vii+191. (London, Bombay and Sydney: Constable and Co., Ltd., 1925.) 12*s.* net.

MALAYA has served as a melting-pot of many creeds as it has been the meeting place of many racial strains. Aboriginal tribes, Malays, themselves a composite people, Hindus, Buddhists, and Arabs have all contributed to the conglomerate which comes under the general term of Malay religion. For although in theory a strict Mohammedan, the Malay sees no incongruity in the inclusion of primitive charms among his invocations, and in the prominence, sometimes pre-eminence, of the magician in relation to the Moslem teacher. Although Skeat in his "Malay Magic" was well aware of the composite character of his material, any analysis, except incidentally or when essential to the exposition of his subject, lay outside the scope of his book. The beliefs of the Malays, however, invite, or rather demand, comparative treatment How far, for example, is the remarkable prominence of the magician in Malay ritual to be regarded as characteristic of a stage of primitive belief? How far can it, as an accompaniment of a peculiar racial strain, be correlated with the highly-strung Malay temperament?

Dr. Winstedt's book is an invaluable, indeed, an indispensable, antecedent to comparative study. He has analysed the tangle into its component parts, describing first the development of the Malay from animist to Muslim, and then the beliefs and rites of each stage. His concluding chapter, which deals with the relation of the magician and all he stands for to the Sufi and Sufi pantheism, is perhaps the most valuable and its subject matter the least generally familiar in the book.

The Spirit of the Wild. By H. W. Shepheard-Walwyn. Pp. xx+220+38 plates. (London: John Lane, The Bodley Head, Ltd., 1924.) 12*s.* 6*d.* net.

THE author of this book possesses an unusual combination of qualities—a lively interest in and sympathy with animals, keen powers of observation, a facile pen, and a sense of humour. It is not surprising that they should have resulted in the most refreshing book on British mammals that we have read for some time. It is not that Mr. Shepheard-Walwyn has anything really new to tell, so much as the arresting and interesting way in which he puts on record his keen observations of living animals, imparting to the reader some of his own enthusiasm for and sympathy with them.

The author does, however, present a new view-point. His book contains twenty-two chapters, each dealing with one British mammal, and he has endeavoured to sum up in the titles to his chapters the outstanding trait in the character of the animal he is discussing, the driving force which directs its every action, which he calls its spirit. Thus the fox is directed by the Spirit of Craft; the mole, the Spirit of Energy; the vole, the Spirit of Vulgarity, and so on. It is an interesting point of view, and, whether one agrees with the author or not, one is bound to admit that he has managed to convey, both in the titles and in the subject matter of his chapters, a living picture of the animals described, and, on the whole, we should agree with his summing up of their characters.

The book is beautifully illustrated by a series of clear photographs, mainly by Mr. H. Mortimer Batten and Miss Francis Pitt, but including some by the author, Mr. R. Kearton and others. This is altogether a delightful book, and we hope it is not the last that the author will produce.

Probleme der Astronomie. Festschrift fur Hugo v. Seeliger dem Forscher und Lehrer zum Fünfundsiebzigsten Geburtstage. Pp. iv+475+3 Tafeln. (Berlin: Julius Springer, 1924.) 45 gold marks.

IT will be a source of satisfaction to all astronomers that this bouquet of writings gathered in homage to Seeliger was published before his lamented death in December last. The volume consists of thirty-six papers, embracing subjects from abstract dynamics on one hand to the latest astrophysical problems, both experimental and theoretical, on the other. The value of the contributions is sufficiently guaranteed by the list of authors, and though selection is invidious, the names of Jeans, Eddington, Schwarzschild (presumably a hitherto unpublished fragment), von Zeipel, Eberhard, Kohlschütter, Plaskett, Emden, Bergstrand, Schlesinger and Shapley will give an indication of the standard maintained. Some of the articles consist entirely of original research. Others give a general summary of recent work in some particular branch—summaries not easily found elsewhere. As particularly valuable ones may be mentioned Ludendorff's "On the relations between the different classes of variable stars," and Guthnick's "Twelve years of photoelectric photometry at the Berlin Observatory"; also Strömgren's (of which the title had better be left untranslated) "Zu Durchmusterung des Probleme restreint" A paper by van Rhijn contains evidence throwing doubt upon the supposed non-existence of M-stars intermediate between giants and dwarfs. Many of the papers are such as can be read with ease by those not specialists in the particular subjects concerned E. A. M.

The Statesman's Year Book: Statistical and Historical Annual of the States of the World for the Year 1925. Edited by Sir John Scott Keltie and Dr M. Epstein. Sixty-second Annual Publication; revised after Official Returns. Pp. xxxv+1531. (London: Macmillan and Co., Ltd., 1925.) 20*s.* net.

THE new edition of this indispensable work of reference appears with its unfailing regularity, and has, as usual, undergone complete revision in its voluminous statistics. As the world settles down there are fewer changes in territorial jurisdiction to record than in recent years, and the number of independent states has ceased to grow. The section on Arabia has been recast and contains a great deal of useful information of recent date. More Russian statistics are now given than was possible a few years ago. The bibliographies attached to each state are a valuable feature of the book, and they have shared the careful revision. Coloured maps show the new boundary between Britain and Italy in Jubaland, and the allied zones of occupation on the Rhine. The introductory tables give statistics of world production of coal, iron, and other commodities and facts concerning the League of Nations. In spite of its 1530 pages, the volume is not two inches thick, which adds to its convenience for reference.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Coherence of Superposed X-Radiations.

WHAT is probably the most remarkable conclusion from the investigation of the *J* phenomenon is that two superposed X-radiations produce effects which are not the sum of those of the two constituent radiations, but are due to the compound radiation as a whole. It is not merely that a constituent of one radiation produces effects in atoms traversed when those atoms are exposed to the action of one or more constituents of the other beam; it is much more than that. The compound radiation, so far as the *J* phenomenon is concerned, behaves as an entity with properties of its own dependent upon (average) penetrating power and not on constituent wave-lengths. This follows as a necessary consequence of the laws which we have found, and have already stated ("The *J* Phenomenon in X-rays," *Phil. Mag.*, May 1925). We have, however, just obtained the most direct and convincing proof of this.

The absorption of an X-radiation scattered from a plate of aluminium was studied by placing an increasing number of thin aluminium sheets in its path to an electroscope. It was found that at a thickness of 0·05 cm. of absorbing aluminium the intensity as measured in the electroscope suddenly dropped by about 7·5 per cent. This was the J_2 discontinuity, as it occurred when the average absorption coefficient $(\mu/\rho)_{Al}$ was about 2·0. Thick plates of aluminium were then placed behind the first scattering plate so that while the original radiation studied was unchanged, there was superposed upon it the more penetrating radiation from a much thicker layer, making the combined radiation (on the average) more penetrating. On filtering this combined radiation by aluminium as before, no discontinuity was observed at the stage found in the first experiment—that is, the discontinuity no longer occurred even in the absorption of that part of the radiation from the first scattering plate. Instead of this a discontinuity of the same magnitude (relative) occurred when the filtering sheets had a thickness 0·02 cm. which was the appropriate position for the discontinuity in the *radiation as a whole*. By "appropriate position" we mean the thickness of aluminium at which the beam as a whole reached the critical absorption coefficient characteristic of the absorber.

Thus two beams which, because of differing penetrating powers, exhibit the discontinuity at differing filtering thicknesses of aluminium, when superposed exhibit not two discontinuities at these thicknesses, but one discontinuity of double magnitude (*i.e.* unaltered relative magnitude) at a thickness between the two shown by its constituents. All this is perfectly consistent with our results from scores of experiments, the discontinuity occurs not at a certain wave-length but at a definite "absorption coefficient" for the whole beam—an absorption coefficient with which we are now perfectly familiar.

The phenomenon may perhaps be more clearly described as one dependent on something analogous to temperature of the X-radiation as a whole, though it is impossible as yet to see how far the analogy will take us. For "absorption coefficient" is more precisely the fractional rate of diminution of ionisation in air (or other gas) with the mass per unit area of aluminium traversed. This again is approximately the rate (fractional) of transfer of energy from the radiation to the matter through which it passes. (In the case of a fluid flowing with constant speed through a substance, this would be governed by temperature of the fluid.)

Indeed, all our experiments on the *J* phenomenon show detachment from mere wave-length and dependence on this absorption coefficient of radiation. The analogy goes further, however, for there is very strong evidence indeed that the *J* absorption discontinuities we have observed are of such a magnitude as just to compensate for a deficiency of absorption which under slightly different conditions takes place continuously. (Such discontinuities occur of course when a liquid is superheated or a vapour supersaturated: there takes place suddenly what would under favourable conditions have been a more gradual change of state.) Correspondingly, when the X-radiation is transmitted through matter, absorption does not take place at the rate which appears under slightly different conditions; but when the discontinuity does occur, the deficiency in absorption occurring previously appears quite suddenly. It is as though there were a sudden evaporation (or condensation) of the energy of radiation, when this is in an unstable state so far as its relation with the surrounding matter is concerned, the energy of the radiation being transferred to electrons in the matter traversed.

It ought not to be necessary to say that in the above experiment the whole process can be repeated in inverse order, any feature of it can be repeated, the discontinuities may be displaced,—in fact, the whole of the phenomenon is under perfect control. The magnitude of these discontinuities, too, is remarkably constant, a long series of experiments giving a drop of $(7\cdot7 \pm 0\cdot5)$ per cent. consistently. Again, we should emphasise that this experiment, though particularly controllable, accurate, and striking, only verifies what, in this laboratory, has been observed less directly in a hundred experiments. The conditions for this "coherence" and its limitations are at present being further studied.

We take this opportunity, too, of announcing that we are now able to show the three discontinuities J_1, J_2 and J_3 one after the other by progressive filtering of a selected X-radiation. Each is indicated by a drop of about 10 per cent. in the intensity of the radiation as usually measured. J_1 was first observed in a scattered radiation; J_2 in a characteristic radiation (*K* series); J_3 in a primary radiation. We now have them all exhibited in one radiation.

We shall describe elsewhere the application of the *J* phenomenon to scattered X-rays.

C. G. BARKLA.
GLADYS I. MACKENZIE.
University of Edinburgh,
May 30.

Radio Transmission Round the Earth.

A THEORY which would explain the facts of long-distance radio transmission must take into account the differences between day and night transmission, long- and short-wave transmission, etc., and must connect these with a plausible assumption with regard to the constitution of the upper conducting or refracting layer, which is believed to function as the chief agency in bending the rays round the earth.

The effect on transmission of such a layer, which has been shown by many eminent scientific men to account in an adequate way for the *bending* of the rays

round the earth, is determined entirely by its capacity for absorption of the energy of the rays which pass by or through it. G. N. Watson has shown that in the special case investigated by him, the absorption suffered by a wave travelling in the space between two concentric shells of resisting material is the same as it would have been had the bounding surfaces been plane instead of spherical. Thus to a fairly high degree of accuracy, absorption and bending are independent of each other, and, as is physically fairly apparent, we can calculate each independently of the other.

It should, therefore, suffice to the first approximation to determine the absorption in the more simple case of transmission between plane bounding surfaces, to get at least a rough measure of the actual absorption in the transmission of waves round the earth.

I should like to give here the results of such an investigation, especially as it seems to explain in a broad way all the main features of long-distance transmission in daytime. In this investigation a radially symmetrical transmitter was assumed to be situated on the earth's surface. At a height "H" above the earth a reflecting layer was postulated, and

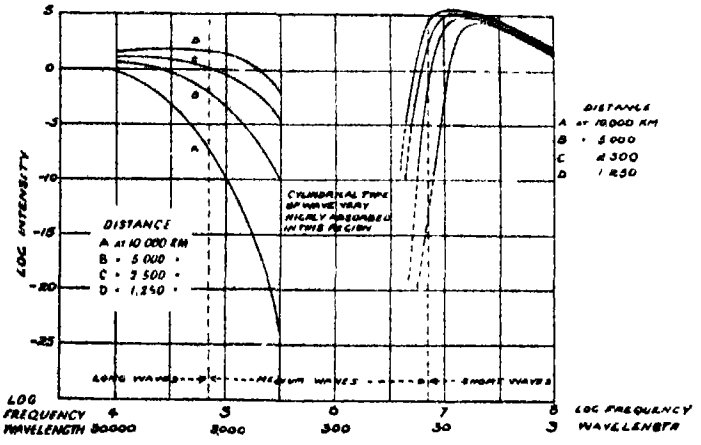


FIG. 1.

the complete problem of the spreading out of electromagnetic waves between the two layers was investigated for all values of electrical constants of the layer as well as for all wave-lengths in the radio range. The constants of the medium which enter directly into the equations are "resistivity" and "dielectric constant" These in their turn depend on the ionic mechanism of the conducting layer, according to the well-known relations of the ionic theory.

By assuming that in daylight the height of the upper layer is approximately 40 km., in accordance with the evidence given in a previous letter to NATURE (April 4), and that τ, the mean time between collisions, is of the order of 10^{-8}, we obtain results which, so far as measurements have been made, are in rough agreement with the observed facts of long-distance transmission. The theory indicates that there are in general two types of wave: first, a cylindrical wave which varies inversely as the square root of the distance, multiplied, of course, by a suitable attenuation factor; and, secondly, a spherical wave varying inversely as the distance. The relative importance of these two types is a function of the wave-length and distance.

The theory further indicates that there are in the daytime three fairly well defined ranges of wave-length, each characterised by a different type of absorption, the transitions from range to range occurring approximately at 40 m. and 4000 m. Short waves less than 40 m. of the cylindrical type, and long waves greater than 4000 m of the same type, suffer only small absorptions; the waves intermediate between 40 m and 4000 m. being characterised by large absorption. In this range only, the spherical type of wave is the most important, but here the theory no longer applies, since this type of wave is largely modified by the earth's curvature

The physical aspect of these effects is fairly obvious, for if the layer were either a perfect metallic conductor or a perfect dielectric with a dielectric constant less than unity, the waves would be transmitted round the earth without loss. On the long waves, where τ is small compared with the time period of the waves, the layer acts as a good metallic conductor, on the other hand, on very short waves the effect of collisional dissipation is very much reduced and the layer acts as an almost perfect dielectric which with ionic loading has an effective dielectric constant less than unity, and consequently bends the rays round the earth with only little loss.

In the intermediate range the loss is a maximum and the absorption is consequently at its greatest.

This should serve in a rough manner to illustrate the numerical results which are shown in the diagram (Fig 1) The ordinates here represent the logarithm of the intensity, and the abscissæ the logarithm of the frequency; the curves are calculated for transmitters of constant "metre amps"; *i.e.* the product of the current in the aerial and the effective height of the aerial is assumed constant

The most marked characteristic of this diagram is the drop in intensity in the intermediate range of wave-lengths, and the sudden rise in signal strength on short waves This illustrates very well the known fact that the absorption on 100 m, say, is so high that transmission over distances greater than about 2000 km in daylight is impossible, whereas on 30 m, daylight transmission over quite long distances, *i.e.* greater than 10,000 km, has been achieved with only little transmitting power

On the long-wave range, *i.e.* waves greater than about 5000 m, the agreement with theory is quite close, for a large number of measurements have been made at varying distances from the transmission stations which agree quite definitely with a transmission formula based on the conducting layer theory (G. N. Watson, Proc Royal Soc., A, vol 95, July 15, 1919), *i.e.* of the form

$$E = \frac{120\pi hI}{H\sqrt{\lambda R}\sin\theta} e^{-\alpha d/\sqrt{\lambda}}$$

It would appear, then, that what may be called the Eccles-Larmor theory of refractive bending, and the Watson theory of a conducting layer, are each applicable in their particular range of wave-length; the former for very short waves, and the latter for very long ones.

T. L. ECKERSLEY.
Research Department,
Marconi's Wireless Telegraph Co, Ltd.,
Chelmsford.

Spiral Springs of Quartz.

IN connexion with some work on gravitation, I felt the need of a spiral spring of greater delicacy than is ordinarily met with in the laboratory. With the help of my assistant, Mr. A. Glodenis, I have succeeded in making satisfactory springs of quartz. Our very first effort with an improvised apparatus resulted in a spring of four turns of about two centimetres

diameter, possessing excellent elastic properties. Three one-hundredths of a gram gave an extension of one centimetre—this was indeed a short and powerful spring in comparison with those we succeeded in making later.

The following is the method of manufacture.

A small hole is drilled into the body of a carbon cylinder near one end, a splinter of fused quartz being driven into this hole Having fixed the cylinder in place as the protruding axle of a mounted wheel, the splinter of quartz is fused to a fixed piece of fused quartz by means of the oxy-acetylene flame The junction, kept as near to the cylinder as possible, is kept constantly heated, while the carbon cylinder moves uniformly with the motion of an advancing screw

It is better to split the cylinder into two halves, separating them at the ends by means of two slightly tapering wedges Having wound a spring, the wedges are carefully extracted and both halves of the cylinder are brought into contact, whereupon the spring can be gently blown on to a thinner glass rod.

Carbon is used because it resists fusion and because it is easier to see the spring on a black background To avoid impairment of vision, it is advisable to view the fusion of the quartz under coloured glass.

K. Šliupas

The Physical Laboratory,
The University of Lithuania,
Kaunas, May 4.

I have read the letter on "Spiral Springs of Quartz" by Dr. Šliupas with very great interest, and I should like, if he will allow me to do so, to congratulate him and his assistant, Mr Glodenis, on their success.

When I was working on quartz fibres in the late 'eighties of the last century I made an attempt in this direction, but an unsuccessful one This was based on a perfectly successful production of a helical spring made of spun glass, and though I showed that at the time I do not remember describing its mode of production. I turned a slightly tapering iron mandrel about $\frac{1}{4}$ inch (5 mm.) in diameter and mounted it so that it could be turned round with its axis either level or slightly inclined A length of spun glass was attached near one end of the mandrel with (I think) a spot of shellac varnish When this was dry a weight was attached to the lower end of the glass fibre The weight was wound up by turning the mandrel as by a windlass and the other end was similarly fastened The helix could be wound either close or with any spacing desired by suitable inclination of the axis The mandrel wrapped with fibre was then buried in fine gunpowder charcoal in a box and heated to fix the form of the helix. At my first attempt I employed a red heat, but the chemical action of the charcoal reduced the lead in the glass and it was no use. Heating another one to some unknown temperature below a red heat completely fixed the form, but in this case the lead was not reduced and a perfect weighing machine was so made. The slight taper facilitated removal of the fibre from the mandrel. I am afraid to say now what small amount was within the limit of observation.

What surprises me about the method of Dr. Šliupas is that he should be able to produce the quartz fibre practically in contact with the carbon cylinder and of useful uniformity. I note that he used acetylene, which I have always feared might have some action on the quartz. For this reason I have never used it or coal gas, only hydrogen. So far as I can remember now I found that a quartz fibre treated in the manner which succeeded with glass had become rotten, and in the light of the reduced lead in the glass I had some misgivings as to the immunity of the quartz, but I did not pursue the matter.

The glass spring made as described above was perfect in its regularity of form. I have some vague recollection that I found that spun glass annealed as described was much more free from "after-working" than raw spun glass, but the perfection of the quartz fibre in this respect caused me to lose interest in the improvement of glass. C. V. Boys.

Bioluminescence.

Recently I had occasion to make an electrical joint in the dark, and while unrolling the insulating tape I observed along the line of separation a band of green light. The tape in question is manufactured by the County Chemical Company, Ltd., of Birmingham, under the trade name "Chemico" Several other types of adhesive tape that were examined did not exhibit the phenomenon.

As the green colour immediately recalled the appearance of the light emitted by certain living organisms, I have ventured to use the above heading, "Bioluminescence."

When the tape is unrolled slowly in a dark room, a faint band of green light appears As the speed of unrolling is increased, the intensity of the light becomes greater, but the colour does not change At moderate speeds the light is remarkably vivid.

Its appearance is not due to any electrical charge which might have been imparted, for example, during the initial winding of the roll. If the unrolled tape is slowly but firmly rewound, the light will again appear when the tape is unwound. Passing the roll repeatedly through a Bunsen flame does not destroy or even appreciably reduce the quantity of light evolved. If the tape is unrolled while totally submerged in cold water, the light appears quite as vivid as in air, but in hot water the intensity is slightly reduced. Similarly, when the tape is heated in air, the intensity appears to be affected, presumably owing to some variation of the viscosity of the adhesive medium

When the line of separation is examined under the microscope, it will be seen that numerous elastic threads are produced and ruptured in the process of unrolling. It is only when the unrolling is stopped that these threads can be seen, as they cannot readily be distinguished when the green light appears, owing to its intensity.

The energy expended in the actual production of the light is probably very small. It is not to be gauged by the energy required to unroll the tape; the same force may be required to unroll two tapes, one of which emits light whereas the other does not.

There can be little doubt that the phenomenon is one of mechanical luminescence; the sudden extension and possible rupture of the tenacious threads into which the adhesive material is drawn apparently results in the emission of light. The question arises as to whether or not the light occurs during the extension of a thread or at the moment of rupture. If under a low power microscope the tape is unwound so slowly that the extension and rupture of the threads can be observed, it will be seen that the rupture is confined to about one-third of the total length of the threads, including their thickened roots. If now the speed of unrolling is increased until the light appears, it will be seen that the whole of the threads, including the thickened roots, are illuminated.

While it is conceivable that, even if the light were only produced at the moment of rupture, it need not

necessarily be confined to the region of rupture, the evidence seems to be in favour of the luminescence being the result of the sudden extension of the viscous substance.

In view of the uncertainty that exists regarding the source of bioluminescence and the scantiness of the evidence in support of even the oxidation theory, a source of light that so closely resembles that emitted, for example by the glow-worm, must be of interest to zoologists and be worthy of further consideration.

It is suggestive that the contents of the luminous cells are so often described as oily, glutinous, and viscid. Is it not possible, therefore, that these gelatinous cells or their granular contents may be capable of sudden longitudinal extension with the production of light of a bioluminous character?

JAMES WEIR FRENCH.

Anniesland, Glasgow, W.2,
May 11.

Dosage with Ultra-Violet Radiation.

THE beneficial results obtained in the treatment of many diseases by the application of ultra-violet radiations raise the question as to which radiation and what amount is specific to a certain effect. This question is rendered the more difficult of answer by the variety of sources used and the lack of specification of the exact conditions of operation.

The variables affecting the health and vitality of a living subject undergoing treatment are sufficiently numerous in themselves to warrant that the ultra-violet radiation used shall be fixed in its character. Records of treatment and effect (which must now daily be compiled) would be rendered the more valuable if the radiations used could be specified. The more accurate the specification is made, both as to spectral character of the radiation as a whole and as to the energy distribution among the various wave-lengths used, the more rapidly will progress result. At best, measurements of ultra-violet energy are difficult, and it is not hoped or suggested that each person responsible for the administration of ultra-violet radiation would make such energy measurements. Help, however, must be afforded to the general user by those exclusively engaged in the study of ultra-violet radiation by intensive attempts at complete and accurate standardisation of the radiations used and in the development of steady fool-proof sources. Both are problems difficult of accomplishment but not impossible, and must ultimately be solved.

Of the devices used as sources of ultra-violet radiation, constancy in the spectral distribution of energy is not approached by any open arc device. Closer realisation of such constancy is given by the use of quartz-enclosed arcs. Referring particularly to mercury vapour lamps, with due specification of the power input and the conditions of use (ventilation, etc.), approximately constant radiation characteristics are realised. The fulfilment of the requirements of constancy and reproducibility of radiation, to be obtained by the use of an enclosed arc, goes hand in hand with the advantages of the manipulation of a fixed closed unit requiring little or no adjustment.

Apart from the sun and open arcs, there exist but three noteworthy sources of ultra-violet radiation available for therapeutic purposes—the mercury arc, the tungsten arc, and the super-heated tungsten filament—each being enclosed in a fused quartz container. The spectral characters of the radiation obtained from these three sources, however, differ greatly. The continuous spectrum of the tungsten filament may be made to reach 290 $\mu\mu$, but the energy in this region is small. The spectrum of the tungsten arc is closely packed with lines, none of which carry a preponderating share of energy. This spectrum tails rapidly in intensity towards 200 $\mu\mu$. The mercury arc spectrum, on the other hand, which extends well into the deep ultra-violet, has the energy of its ultra-violet radiation concentrated about relatively few wave-lengths.

Despite these great differences in the spectral character of the radiations, no great and fundamental distinction appears so far to have been made between the result obtained in the treatment of disease and in the irradiation of vitamin-deficient food-stuffs by radiation from these various sources.

Is it, therefore, to be concluded that radiation belonging to one (or several) of the intense lines in the mercury arc spectrum is responsible for the beneficial therapeutic results obtained? The question presses for answer. The production of vitamin properties in food-stuffs appears to be a subject peculiarly amenable to exact study, and an examination of the results to be obtained by the ultra-violet irradiation of vitamin-deficient food-stuffs using the different sources in turn and with complete specification of the conditions of their use, would help towards our understanding of the mechanism of the changes which are induced.

H. D. H. DRANE.

Research Dept.,
The Thermal Syndicate, Ltd.,
Wallsend-on-Tyne.

The *K* Absorption Levels of the Light Atoms: A Correction.

IN Roy. Soc. Proc., A, vol. 104, p. 455 (1923), I gave the results of measurements of a number of "soft" X-ray absorption levels. The ν/R values of the levels were deduced from the kinetic energies of the groups of electrons expelled from the atoms by X-rays of known frequency. In most cases the results agreed very well with the values deduced from spectroscopic X-ray data, but fairly wide systematic deviations were observed in the case of the *K* levels of the light atoms—my values being appreciably higher than those previously accepted. In the case of the oxygen *K* level the value of ν/R came out 42·3, which is 4 units—more than 50 volts—greater than Kurth's value of the *K* critical excitation potential for oxygen (Kurth, *Phys. Rev.*, 18, p. 461, 1921).

As was pointed out in the original paper, my method of measurement was not suitable for exact determinations of very "soft" levels: the results in these cases come out as the difference between two large and nearly equal quantities, one of which is deduced from the measurement of a magnetic field and a radius of curvature, while the other is taken from the X-ray spectroscopic tables. Any inaccuracies in the values of the universal constants e, e/m_0, and h would introduce systematic errors into the calculations, the effects of which would be most marked in the case of the levels of lowest energy. Apart from uncertainties of this kind, an error of 1 part in 1000 in the absolute value of the magnetic field would cause an error of nearly 3 per cent. in the value of ν/R deduced for oxygen *K*. I stated, however, at the time that the deviations of my results from the older results were too big to be accounted for by defects in the method or errors in the measurements (*loc. cit.* pp. 478-9). I now wish to correct this statement.

I have recently extended the series of measurements of corpuscular spectra, with new and improved apparatus (work now in course of publication in the

Phil. Mag.). The new measurements of such of the *L*, *M*, and *N* spectra of the heavier atoms as have been repeated agree excellently with my original values (within 1 part in 1000) In recording the spectrum of uranium with a target of uranium oxide, I obtained, however, a line which was clearly due to the oxygen *K* level. This line falls about midway between the uranium N_V and N_{VI} levels, which are fairly widely separated Measurements on this gave a much lower value for the oxygen *K* level—namely, ν/R 36·7 instead of 42 3—and this led me to redetermine the other values for the light atoms The revised values are .

Element.	ν/R *K* level	Other Values
20 Calcium	296 6	297 5 F
16 Sulphur	180 3	181·8 F.
12 Magnesium	93 6	95 8 F
11 Sodium	76 6	
8 Oxygen	36 7	35 3 M 38 3 K

F. = Fricke, M = Mohler and Foote, K. = Kurth.

It is clear from the new measurements that in the earlier experiments the Helmholtz coils must have moved During the work on the heavier elements the magnetic fields were calibrated from time to time and found to remain perfectly constant The light atoms were tested at the end, just before the apparatus was dismantled, and no re-calibration was made in this case. The new work shows quite clearly that only the measurements on the light atoms were affected by this accident. H ROBINSON

Physical Laboratory,
The University, Edinburgh,
May 27

Anomalous Dispersion and Multiplet Lines in Spectra.

RECENTLY, H. B Dorgelo has carried out a series of measurements of the intensities of the components of multiple spectral lines (Dissertation, Utrecht, 1924) and obtained results of great interest He found that the doublets of the sharp series of the alkalies had a 2 : 1 ratio of intensity, the triplet components of the sharp series of the alkaline earths had a 5 · 3 · 1 ratio, the triplets of the sharp series of a sextet system had a 4 · 3 · 2 ratio, and the triplets of an octet system a 5 : 4 · 3 ratio The theoretical interpretation of this result has been discussed by Sommerfeld ("Atombau," Fourth Edition, p 649) and by Ornstein and Burger (*Zeit. für Physik*, 1924, 24, p 41) As illustrations of Dorgelo's work may be quoted the case of the triplets of manganese 6021, 6016, 6013, which show a 4 · 3 : 2 intensity ratio

Probably the best known case of the existence of simple intensity relationships of this kind are the two D-lines of sodium, for which a 2 1 ratio has long been shown The anomalous dispersion of sodium vapour has been extensively studied, notably by Roschdestwensky, who found (*Ann der Physik*, 1912, vol 39) that of two constants a_1, a_2 in the dispersion equation

$$n = 1 + \frac{a_1\lambda^2}{\lambda^2 - \lambda_1^2} + \frac{a_2\lambda^2}{\lambda^2 - \lambda_2^2},$$

where λ_1 and λ_2 are the wave-lengths of the two D-lines, a_1 was just twice as large as a_2. Dorgelo's work suggests that, in the case of multiplet lines, similar numerical relationships between the constants of anomalous dispersion should be found. Unfortunately, very little in the way of quantitative data on anomalous dispersion is available except in the case of the alkali metals.

Perhaps the best work in this direction is that of A. S. King at Mount Wilson, who with the electric furnace studied the anomalous dispersion of iron, chromium, titanium, and manganese lines (*Astrophysical Journal*, 1917, 45, p. 254). An enlarged photograph of the anomalous dispersion due to the manganese triplet 4031, 4033, and 4035, which belongs to the sextet system, reproduced with King's paper, has been examined, and it is found that the dispersion constants a_1, a_2, and a_3 of the lines deduced from the photograph agree closely with the 4 3 : 2 ratio to be expected on theoretical grounds. In the case of the chromium triplets 5208, 5206, and 5204, Dorgelo obtained experimentally an intensity ratio of 100 72 : 45, while King's photographs give the ratio of anomalous dispersion to be roughly as 100 . 75 . 50, which is a fair agreement A careful study of the original negatives secured at Mount Wilson may be suggested as likely to furnish further data regarding these interesting spectral relationships

C. V RAMAN
S K DATTA.

A New Standard Solution for Sahli's Hæmometer.

SINCE Sahli's hæmometer has come more and more in practical use for the colorimetrical inspection of human blood, there has been no lack of experiments to obtain a standard liquid which will keep its colour in daylight better than the indicated hæmatine solution Most experimenters have clung to Sahli's principle, that in quantitative determination of the contents of iron in blood, the standard liquid should be, so far as possible, the same as the blood solution to be examined This research is limited to the derivatives of hæmoglobin and has not yet produced the desired result, so far as I know.

The cheapness of the instrument being admitted as a main factor, leads to the use of aniline and similar fluids as a standard. These products have not the slightest chemical relation with hæmoglobin ; and they all have the fault that they do not retain colour.

A third standard is the coloured solid glass staff—in fact the combination of Fleischl's and Sahli's hæmometer. Although the colour of the glass seems to last, this standard gives different results, depending upon the kind of light in which the blood determination is made.

I think it advisable to use as a standard a solution of chlorophyll (or related products—the phlobaphenes), namely, an extract of leaves, browned to the darkest tint. It has been proved to be possible to get in this way a solution imitating absolutely the colour of Sahli's standard, having the following advantages :

(1) Chlorophyll is from a biological and chemical point of view more similar to hæmoglobin than any other chemical product (except the hæmoglobin-derivatives). This advantage is only theoretical.

(2) This solution contains a natural brown colour formed by sunlight (or a similar physical process), so that it seems logical to think it impossible that this colour, once isolated, should undergo further change.

(3) This solution is easily made and is cheap.

The simplest way of making this standard solution is as follows :—Tea leaves should be macerated for one hour in an antiformine-water mixture (for example, 1-10). The more tea leaves are taken, the darker the extract becomes. The brown extract so obtained is filtered and the antiformine solution added to it, in a clean glass tube of exactly the same size and kind as Sahli's, until the colour is that of Sahli's standard. The comparison can be made "*à vue*" or with other

colorimetrical methods. The tube is closed by heating the opening, and is now ready for use.

I made a solution for a standard tube one year ago, and although it has been exposed to different kinds of light all the time, it has not changed.

A. K. J. KOUMANS

University Hospital, Leyden, Holland,
May 5.

Approximations to the Probability Integral.

RECENT numbers of NATURE contain two interesting approximations to the probability integral, one by Prof H. C. Plummer (October 25, 1924), and one by Mr. S. Krichewsky (January 10, 1925) A comparison made by the latter shows that of the two different formulæ Prof. Plummer's is more accurate for small values of the argument, but breaks down completely for $x/\sigma > \sqrt{6} = 2\ 449$

In my opinion, however, the most significant point about such approximations, and the one on which their practical usefulness depends, is the integrability of the resulting equation In stellar statistics, for example, we are constantly dealing with problems involving integration of the incomplete probability function, and an analytical approximation to erf (x) is then invaluable.

I take it that Mr. Krichewsky's formulæ (3) and (5) should read as follows:

$$z = k\left(\frac{a^2}{4} - y^2\right),\ y = \sqrt{\frac{a^2}{4} - 10^{\alpha}},$$

giving: $$y = \frac{a}{2}\sqrt{1 - 10^{-0.5354\, x^2/2\sigma^2}}.$$

This last expression is not integrable In fact, it is much more difficult to handle, and much more inconvenient to expand into power series, than the original exponential function or its integral.

Prof. Plummer's formula $\operatorname{erf}(x) = \frac{6}{\sqrt{\pi}} \frac{x}{x^2+3}$ is extremely simple, and, when integrated, gives rise to an arc tangent or a logarithm

Concerning the usefulness of approximations when the *values* only of the probability function are needed, it may be pointed out that Mr. Krichewsky's formula requires a table of logarithms, and even then takes more time than interpolation from a probability table. Prof. Plummer's formula can easily be memorised, and the entire calculation can be done in one's head, in about the same time as it takes to interpolate from a table. W. J. LUYTEN.

Harvard College Observatory,
Cambridge, Mass.

The Word "Australopithecus" and Others.

ALL will admit that many words of Greek origin were used by the Romans, and that *pithecus* was one of them. The evidence adduced, however, does not prove that *pithecus* was regarded as a Latin word. The *pithecium* of Plautus is not a Latin diminutive; it is merely a latinisation of an ordinary Greek diminutive. Had a Roman regarded *pithecus* as Latin, he would not have used the Greek word for "tail" to combine with it: *cercopithecus* is of course pure Greek. Nevertheless had the Roman lived to our day and turned zoologist, he might under stress of circumstances have combined *pithecus* with a word of Latin origin. Circumstances, it is true, did not stress; a good Greek word for "south" was available, and a Roman, especially a "polished Roman," would probably have used it.

But heaven preserve us from pedantry in such matters! The reason for this letter is that Prof. Dart (NATURE, June 6) does not yet realise the many-sidedness of his offences. No Roman, polished or rude, would have used the adjective instead of the substantive Had Prof. Dart written *Australopithecus* we should merely have shrugged our shoulders and Australia would have had no grievance

Then "Homosimiidæ"! The word is *not* "parallel with Pithecanthropus or Anthropopithecus," because they are correctly compounded and this is not. But, apart from orthography, if a family is to be erected for the special reception of *Australopithecus*, its name, according to the rules, has to be Australopithecidæ. So that's that.

The moral? Not that a distinguished anatomist must necessarily be a classical scholar, but that any one who sets out to propose a name should realise all his responsibilities. In a word, if you want to join in a game, you must first learn the rules

F. A. BATHER

A New Locality for Jurassic Insects.

MR A. J LAVRUSHIN, a keen student of geology, who was my interpreter in Siberia, has sent me a careful drawing of a fossil insect which he received from a teacher in the Commercial School at Harbin. It was obtained near the coal mines at Soochan, in the Maritime Province of Siberia The deposit is known to be Jurassic, probably middle or lower Mr. Lavrushin says the rock is like that typical of the lower Jurassic The figure appears to accord perfectly with the larva of the stone-fly *Mesoleuctra gracilis* Brauer, Redtenbacher, and Ganglbauer, known from the Jurassic (supposed middle Jurassic) at Ust Balei, west of Lake Baikal. It seems probable that we have another exposure of these insect-bearing beds, about 1500 miles from the original locality. This, if confirmed, may prove to be a matter of more than ordinary interest For an account of the Ust Balei deposit and its significance see Bull. Amer Museum Nat History, 1924, p 134. T. D A. COCKERELL.

University of Colorado, Boulder,
May 16.

Mercury Helide: A Correction.

IN a former note (NATURE, March 7, p. 337), I stated that a quantitative analysis of mercury helide showed that 210·79 parts by weight of mercury combined with 4·18 parts by weight of helium I have to regret that this is incorrect In checking the calculations before incorporating the results in my paper (now ready for publication), I discovered that a decimal point had been misplaced. In consequence of this the stated weight of mercury was ten times greater than that actually found The simplest assignable formula is therefore $HgHe_{10}$ and not HgHe as at first given. J. J. MANLEY.

Daubeny Laboratory,
Magdalen College, Oxford, June 4.

Quantum Radiation.

WITH reference to my short letter in NATURE of May 30, p. 838, will you allow me to say apologetically that instead of finishing it off abruptly with the statement that the usual formulæ follow, it would have been better if I had said: "After that no doubt the real difficulties begin." My only object was to direct attention to the peculiarity of the fraction $x/(e^x - 1)$ as almost irresistibly suggesting continuous compound interest growth followed by sudden emission.

ALFRED LODGE.

A New Determination of the Distribution of Stars with respect to Magnitude and Galactic Latitude.

By FREDERICK H. SEARES and Prof. P. J. VAN RHIJN.

THE significance of the numbers of stars visible in different parts of the sky has been recognised since the time of Sir William Herschel, whose star gauges first indicated the flattened, watch-shaped form of the galactic system. The stars having parallaxes which can be measured, either by trigonometric or spectroscopic methods, are all so near that their distances tell nothing of the structural features of the system. These must be learned from counts, like those of Herschel, of stars of different magnitudes in different parts of the sky.

Were the stars all equally luminous, it would be easy to find their distribution in space. Differences in apparent brightness would then be wholly an effect of differences in distance, and star-counts, together with the parallax of a single star, would determine the distances of all objects within reach of our telescopes. Actually, the range in stellar luminosity is enormous, at least 100,000,000 to 1. Differences in luminosity, however, can be allowed for, provided we can find the numbers of stars of different intrinsic brightness in a given volume of space;[1] but this problem has not yet been satisfactorily solved

Investigations by Kapteyn and van Rhijn indicated that the distribution of luminosity could be represented by a Gaussian error curve, with a maximum frequency for luminosities 0·07 that of the sun. The present authors, however, have independently shown that this maximum is not real and that the frequencies continue to increase probably at least so far as luminosities equal to 0·001 that of the sun. The highly luminous stars, on the other hand, are well represented by the ascending branch of an error curve. Thus at present we have an excellent approximation for the relative numbers of stars intrinsically brighter than the sun, which stands about midway in the known range of luminosity, but only general indications as to the behaviour of fainter stars. This somewhat restricts the immediate usefulness of star-counts but does not lessen their ultimate value.

The star gauges of Sir William Herschel were extended to the southern hemisphere by Sir John Herschel in 1834–38, and the accumulation of star-counts thus begun has been continued by others, in recent years especially by Kapteyn and van Rhijn, whose respective distribution tables are in "Groningen Publications," Nos. 18 and 27. Successive revisions of the data have extended the counts to larger areas of the sky and to lower limits of brightness, and have also improved the scale of magnitudes to which the counts are referred.

The serious practical difficulty lies in the magnitude scale, which must be accurate if the counts are to be useful. The range in apparent brightness covered by large telescopes is 20 magnitudes or more. The establishment of standards over this interval requires the ultimate comparison of light sources the intensities of which are in the ratio of at least 100,000,000 to 1. Under the most favourable conditions, sources of the same order of brightness and of the same colour can be compared with an uncertainty of about 1 per cent.; but as the differences in brightness and spectral composition increase, the uncertainty becomes much larger. Comparable difficulty in the measurement of lengths would mean, for example, an error of several inches in determining the dimensions of a room. An ordinary yardstick does a hundred times better than this, let alone the precise methods of laboratory measurement.

The difficulty of bridging a long interval of brightness by visual methods is illustrated by the scale underlying Kapteyn's table of stellar distribution This, the best visual scale available up to 1915, is now known to be a magnitude in error at the sixteenth magnitude, the equivalent of 150 per cent. in the light-intensity of the stars to which this magnitude was assigned. Mainly because of this same difficulty the conspicuous increase in the concentration of stars in the Milky Way with increasing magnitude, which was already indicated by the gauges of Sir John Herschel, remained an open question until 1917, when counts of 40,000 stars observed photographically at Mount Wilson put the matter beyond doubt.

The application of photographic methods by Pickering and Miss Leavitt did much to increase the precision, and the resulting Harvard photographic scale, defined by a sequence of stars at the North Pole, is the basis of the distribution table of van Rhijn. Investigations in photographic photometry begun at Mount Wilson in 1910 led to the Polar standards of brightness published by Seares in 1915. These were afterwards strengthened by additional data, and to the sixteenth magnitude have been confirmed at several observatories; below the sixteenth magnitude, however, the Mount Wilson standards are still the only ones available.

These investigations, which comprise the Mount Wilson contribution to the International Scale adopted at Rome in 1922, were preparatory to a study of the distribution of faint stars in the 139 Selected Areas of Kapteyn between the North Pole and declination $-15°$, an undertaking now finished. The individual magnitudes will be published in the "Mount Wilson Catalogue of Selected Areas." The detailed discussion of the counts based on these magnitudes and a revision of certain earlier results will also be published elsewhere. Some matters of general interest, however, may be summarised here.

The new distribution table depends on: (*a*) The Mount Wilson "Catalogue," which completely determines the distribution for stars between magnitudes 13·5 and 18·5; (*b*) Van Rhijn's tables, "Groningen Publication," No. 27, reduced to the international scale by (*a*). These afford results for the interval $m = 4·0$ to 9·0 and establish the scale for counts from a third source, (*c*), consisting of 33 zones of the Astrographic Catalogue between declinations $-65°$ and $+62°$. These counts, published by Turner, include about 1,400,000 stars and determine the distribution in the interval $m = 9·0$ to 13·5.

The Mount Wilson "Catalogue" (*a*) is based on two partially independent investigations: (a_1) measures

[1] Practically we are obliged to assume that the relative numbers are the same at all distances.

made at Mount Wilson on photographs of 15 minutes exposure or less, which establish the scale and give the magnitudes of 65,683 stars in fields 23′ in diameter; and (a_2) measures at Groningen on Mount Wilson photographs of 60 minutes exposure. These give the magnitudes of 44,910 stars in fields 15′ × 15′ or 20′ × 20′, based on standards derived from (a_1). Most of these stars are included in (a_1), so that the total number of individual objects is approximately 70,400. The magnitudes are on the international scale.

The fields in the 139 Selected Areas cover but 1/2500 of the entire sky. Nevertheless, examination shows that had the alternate areas been discussed separately, the two series of counts would have led to nearly identical results. Individual areas show large deviations from the mean, but with the exception of regions in the Milky Way there is little systematic uncertainty. This perhaps as well as anything illustrates the underlying statistical unity of the stellar system. Properly selected, 1/5000 of the stars between magnitudes 13·5 and 18·5 reveal the main features of the distribution with only a small percentage of error.

The densities derived from the combination and adjustment of data for the three intervals 4·0-9·0, 9·0-13·5, and 13·5-18·5 are so regular that they have been extrapolated to the twenty-first magnitude, which is the practicable limit for long-exposure photographs with the largest telescopes. The table, which thus covers a range of 17 magnitudes, gives the logarithm of the average number of stars per square degree brighter than photographic magnitude m($\log N_m$) situated in different galactic latitudes. Local irregularities, differences between northern and southern latitudes, and systematic deviations in longitude have been ignored for the present. Averages for latitude intervals 0°-20°, 20°-40°, 40°-90°, and for the whole sky are also given. Correction of the magnitude limits for colour leads to average densities for the entire sky for a grouping of stars according to *visual* magnitude. The complete transformation of the table to visual limits cannot be made at present because of lack of data for the variation of mean colour with galactic latitude.

The total number of stars to the twenty-first photographic magnitude is $8·9 \times 10^8$, or, to the twentieth visual magnitude, a round 10^9. It is difficult to specify the uncertainty attached to these numbers. There is no means of testing the magnitude scale for the very faint stars; but if the limiting magnitude of the table is correct within one or two tenths, we may consider ourselves fortunate. Since the average change in N_m per magnitude at the limit is about one-half of N_m itself, the uncertainty in the totals from this source alone can scarcely be less than 5 or 10 per cent. Errors in the final counts arising from the choice of regions used as samples, as already stated, must be small, except possibly in low galactic latitudes. The fields in the Milky Way are not numerous, nor are they well distributed in galactic longitude, and the tabular densities are here subject to considerable uncertainty, although the amount cannot be stated.

For bright stars at all points in the sky, the ratio of totals to successive magnitude limits N_{m+1}/N_m is 2·9. With decreasing brightness this ratio falls off, but most rapidly in the direction of the galactic poles. Thus in passing from the twentieth to the twenty-first magnitude the total in the Milky Way is increased 1·8 times, while at the poles the increase is only 1·4 fold. Were the stars uniformly distributed in space, the ratio (excluding losses of light by absorption, scattering, etc.) would be constant and equal to 3·98. The actual ratios therefore show that the stars thin out with increasing distance from the centre; that at great distances they thin out more rapidly than near the sun; and that this thinning out is most pronounced in the direction of the poles of the Milky Way—results obviously related to the flattened, watch-shaped form of the system.

The variation in $\log N_m$ can be used to estimate the probable total of all the luminous stars, both visible and invisible, in any direction, and hence also the total for the system. Earlier data indicated that dN_m/dm could be represented by an error function for practically all values of m to the limit of the counts. It was, therefore, natural to assume that the law also applied to stars too faint for observation, whereupon a simple integration gave the required total. The relation between star-counts and the luminosity and density functions indicates, however, that the values of dN_m/dm for the brighter stars cannot be well represented by an error function, and the present counts confirm this conclusion. Below the twelfth or thirteenth magnitude the representation is excellent, but above this limit the second differences in $\log (dN_m/dm)$ are not constant. This restriction raises a serious question as to whether the error function applies to the invisible stars. For lack of anything better, we assume that it does apply, and thus find Total number of stars per square degree in galactic latitude 0°, 5,320,000, one-half of which are fainter than magnitude 30·6. For latitude 90° the total is 7160, with one-half fainter than magnitude 23·9. The corresponding totals to $m = 21·0$ are 73,600 and 1667 respectively. Hence in the direction of the poles of the Milky Way about one-fourth of the stars between the sun and the limits of the system are accessible to observation. In the direction of the Milky Way the fraction is one-seventieth.

Stars of all magnitudes are most numerous in the Milky Way, but the concentration in the galaxy is obviously much greater for faint than for bright stars. At the fourth magnitude the ratio of the values of N_m for 0° and 90° is 3·5; at the twenty-first magnitude it is 44; to the limits of the system, 743. The importance of the Milky Way as a structural feature of the system is also indicated by the fact that 95 per cent. of all the stars are within 20° of the galactic plane. The remaining two-thirds of the sky contain but 5 per cent., of which less than 1 per cent. is in that third between latitudes 40° and 90°.

Three different methods of summation give values for the total in the system ranging from $3·0 \times 10^{10}$ to $3·7 \times 10^{10}$, of which the lower limit is the most probable value. This, however, like all other results depending on the assumption that the adopted formulæ for dN_m/dm hold to the limits of the system, is very uncertain. Even at the galactic poles, where a considerable fraction of the stars can be observed, the extrapolation is risky enough; and naturally it is very much more so in the Milky Way, where apparently

less than 2 per cent. of the stars are within observational reach. But whatever the actual total, it is clear that the number of stars beyond the range of the largest telescopes is many times that accessible to observation.

The total amount of starlight is little affected by questions as to the number of stars in the system. For the distribution given above, the stars brighter than the twentieth visual magnitude, comprising but 3 per cent. of the total, contribute 98 per cent of all the starlight The integrated visual light for the whole sky is the equivalent of 1076 stars of visual magnitude 1·0 on the international scale. The corresponding numbers found by Yntema and van Rhijn from measures of the brightness of the sky are 1350 and 1440, the unit being referred to the Harvard scale. The outstanding difference corresponds to about 0 3 mag. Since the stars of about the twelfth apparent magnitude contribute the largest amount of light, no reasonable correction to the magnitude scale will wholly account for the difference.

The Expedition of the R.R.S. *Discovery*.

THE Royal Research Ship *Discovery*, which is leaving England at the end of the present month, will be engaged for the next two years in oceanographical investigations in the South Atlantic and Antarctic The ship, which is barque-rigged with auxiliary steam, was built in 1901 for the late Captain Sir Robert Falcon Scott, and was acquired on behalf of the Falkland Islands Government for the purpose of the present investigations in 1923 During the last eighteen months she has undergone extensive repairs, and changes have been made in her masting and sail-plan in accordance with experience obtained by Capt Scott She has been refitted throughout, and is now completely equipped for the investigations for which she is intended

The cost of the expedition will be met entirely from public revenues raised in the Dependencies of the Falkland Islands, and the work will be controlled, subject to the instruction of the Secretary of State for the Colonies, by an executive committee, constituted as follows: Mr. E R. Darnley (Colonial Office, chairman); Sir Sidney Harmer (British Museum, vice-chairman); Sir J. Fortescue Flannery, Bt. (consulting naval architect); Mr. H T Allen (Colonial Office); Mr. J. O. Borley (Ministry of Agriculture and Fisheries), Capt J D. Nares (Admiralty), and Mr. J. M. Wordie (Royal Geographical Society): Mr. H. Horsburgh (technical assistant); Mr. E. W. Baynes (secretary).

The scientific officers of the expedition are Dr Stanley Kemp (Director of Research); Messrs. A C. Hardy, J. E Hamilton, N. A Mackintosh, J. E G. Wheeler, L H. Matthews, and E. R. Gunther (zoologists); Messrs. H. F. P. Heardman and A J. Clowes (hydrologists). Messrs. Mackintosh, Wheeler, Matthews, and Clowes are at present serving at the shore station, South Georgia. The marine staff includes: Commander J. R. Stenhouse (captain); Lieut.-Commander W. H O'Connor (chief officer); Lieut.-Commander J. M. Chaplin (second officer and surveyor); Eng.-Lieut. W A. Horton (chief engineer), and Lieut.-Colonel E. H. Marshall (surgeon).

The principal object of the expedition is to obtain information bearing on whales, more especially on those species which form the basis of the industry now flourishing at South Georgia and in the South Shetlands. Although the whale fisheries in these places are controlled by Government regulations, very little is known of the habits and migrations of the animals and of the reasons for the fluctuation in their abundance. It is, indeed, not yet certain whether the closely similar Arctic and Antarctic whales are specifically identical. There is, therefore, much information to be acquired before a satisfactory basis for the control of the industry can be found.

In connexion with the investigations, a laboratory has been established in Cumberland Bay, South Georgia, where examination is being made of the whales captured at the adjacent whaling station. At this laboratory good progress has already been made, for, although the building was only completed in February, 181 whales had been examined by April 10.

Work on the *Discovery* will mainly be directed towards obtaining information on oceanographic conditions in the waters frequented by southern whales, and routine observations on the hydrography and plankton will be made throughout the voyage. On the whale feeding-grounds intensive work will be undertaken and a close study made of the euphausians, which occur seasonally in great abundance, and constitute the principal, if not the only food of southern rorquals Plankton nets will be employed at all depths, the smaller hauled vertically and the larger, up to a diameter of 4½ metres, horizontally. New apparatus for opening and closing horizontal nets will be tried, together with a mechanism designed to allow of a number of vertical nets being operated on a single line. A very large midwater trawl, with three otter boards, 250 feet in length and with a mouth area of about 1500 square feet, will be used in an attempt to obtain large pelagic organisms, particularly cephalopods, which would be able to avoid smaller nets. Depth recorders, of pressure gauge and thermometer types, will be used to check the depths at which towed nets are fishing. For work on the bottom the ship is provided with dredges of various kinds, traps similar to those designed by the Prince of Monaco, the Petersen grab, and both beam and otter trawls, but the latter will ordinarily be used only on the coastal banks where fish in commercial quantities are likely to be found.

The deck equipment for biological and hydrographic work comprises a large trawling winch carrying 5000 fathoms of tapered warp on one reel and 1000 fathoms of trawl warp on the other. An auxiliary reel with 3500 fathoms of 6 mm. wire is driven from this winch. For vertical nets and hydrographic appliances there are four smaller reels, driven by three engines and all fitted with 4 mm. wire. Two of these reels carry 3500 fathoms of wire for deep observations and two carry 500 fathoms for observations at lesser depths. A Lucas sounding-machine is installed with various attachments for the collection of bottom samples, and a dynamometer, accumulators, metre recorders, an electric centrifuge, and other subsidiary apparatus are provided. There are two laboratories on the ship, one on the upper and one on the main deck, completely equipped for biological and hydrographic work.

Adequate photographic apparatus and a dark room are provided.

The ship is well supplied with apparatus for taking observations while under way. Two sets of echo-sounding gear, for shallow and deep water, have kindly been lent by the Admiralty, and a distance thermograph, designed to give a continuous record of surface temperature, has been fitted. The Knudsen full-speed water-bottle will provide water-samples at some distance below the surface, and it is hoped that a new piece of apparatus, designed by Mr. A. C. Hardy, will furnish a continuous record of the more important organisms in the plankton.

The *Discovery* is not equipped with harpoon guns of the commercial type, but will carry smaller patterns, with which it is expected that Cetacea up to 25 feet in length can be obtained. Observations on living whales will be made whenever possible, and it is hoped that valuable information on their migrations will result from marking experiments The form of mark has been adopted after repeated tests on the shooting-range with a target made of whale blubber, and after practice on living whales made by Prof. Hjort and a member of the *Discovery* staff who accompanied him. The mark is similar in form to a large drawing-pin, with three barbs on the shank, and is made of annealed cast-iron and silver-plated. The pin is 2½ inches in length and the disc nearly 2 inches in breadth, with a number stamped on it, together with an inscription offering a reward for return to the Colonial Office Posters and leaflets are being circulated to all the whaling stations of the world giving instructions for the return of the marks, together with the required information. The mark is placed on the end of a light wooden shaft, and is fired from an ordinary 12-bore gun. With this apparatus good practice has been made at ranges up to 70 yards, and the marks embed themselves well even with the target at an oblique angle. The pin is not long enough to penetrate the blubber, and the operation of marking is thought to be quite painless. It is feared that the *Discovery* may be too slow and unhandy to mark whales in any considerable number, but whale-marking will form a large part of the work of a small auxiliary vessel, of high speed and built on the lines of a whale-catcher, which is now under construction.

Geographical exploration is not included in the programme of the expedition, but it is hoped that the echo-sounding gear will provide valuable data in Antarctic waters, and every effort will be made to improve our knowledge of the coast-line and to survey harbours frequented by the whaling community The second officer of the ship is a qualified surveyor, whose services have been lent by the Admiralty

Work will begin in the Gulf of Guinea, which is thought to be the northern limit of migration of southern whales. Observations will be made on the plankton and hydrography of this region, and the whaling stations on the West African coast will be visited After touching at Cape Town a course will be laid for South Georgia *via* Tristan da Cunha and the Falkland Islands. On reaching South Georgia a close survey will be made of the whaling grounds, and, as at present arranged, in January 1926 the ship will make a passage to the South Shetlands by way of the South Sandwich group, proceeding still farther south to the Neumayr Channel if ice conditions are favourable. In March a return will be made to South Georgia, a line of stations being made between Graham Land and Cape Horn if weather permits. A fresh survey of the whaling grounds is then contemplated, and later in the year, during the Antarctic winter, the ship will possibly return to the African coast Operations in the second year will depend largely upon the results obtained during the first.

Obituary.

M. Camille Flammarion.

THE death of Camille Flammarion at the age of eighty-three years removes from the world of astronomy one of its greatest ornaments, and one of the most picturesque figures in French scientific circles generally. It is difficult to contemplate astronomy in France without the guiding hand of its beloved "maître," whose "élèves" are counted in all branches of society in all lands.

Camille Flammarion might be described as the apostle of popular astronomy. His numerous literary works had for object primarily the popularisation of astronomical study in all its manifold branches, and it is upon the record of success achieved by those works that his reputation as a scientist should stand or fall. Throughout his life this was a passion with him, kept constantly in view, and meeting with extraordinary success in the birth of the Société Astronomique de France in 1887. This notable Society, recognised by the Republic ten years later as being of public utility, now comprises thousands of members of all nationalities, united by a common love of the sky.

Flammarion was not content to spread abroad the gospel of astronomy by book and pamphlet. He believed in the practical application of his theories for the spread of a universal knowledge of the sky. Although he was not openly impatient of the restraint imposed on the professional astronomer by the routine of the national observatories, which exist chiefly for the many problems involved in the determination of time and position, it is common knowledge that this branch of astronomy appealed to him very little. His interest lay principally in the discussion of the physical facts observed through the telescope, a much more picturesque branch of the science. He was frankly proud of the scientific independence of his observatory at Juvisy and its freedom from official restraints and controls.

With most modern observatories nowadays devoting special attention to the study of the physical and vital constitution of the celestial bodies, astrophysics has definitely taken its place alongside mathematical astronomy, and it is not going too far to claim that this extension of activity is due in large measure to the demand which arose from the interest created by Flammarion in his efforts towards what the French call the "vulgarisation" of astronomy.

In the year 1882 an unknown admirer, M. Méret,

conveyed to Flammarion, *regium donum*, the beautiful estate and chateau at Juvisy, a few miles south of Paris, where he has since made his home. Here he installed and equipped a magnificent astronomical observatory, to which in later years he added a meteorological and climatological station which is under partial subvention from the French Ministry of Agriculture,—the only climatological station in France, as Flammarion himself boasted, established in direct connexion with the physical study of the sun.

At Juvisy, in the most charming surroundings, the weather is studied in extraordinarily minute detail. The astronomical observatory is thrown open to the eager student of the sky, and competent amateur observers are encouraged to undertake serious observational study there,—perfect instrumental equipment combining very happily with a perfect position, deep in the wooded country and yet within sight of Paris, whose upstanding wonders, the Eiffel Tower and the domes of Les Invalides and the Panthéon, are visible from the observatory terrace

It was my privilege to visit M and Mme. Flammarion at Juvisy in the summer of 1914, just before the outbreak of War, and the memory of that experience will not readily be effaced Conversationally, M. Flammarion was a man of few words, a characteristic not uncommon among very prolific and highly imaginative writers During a conference of French-speaking astronomical societies which lasted three whole days he rarely joined in the debates, notwithstanding that the subjects discussed were nearest his heart, and that none was present better qualified to deal with them. Once in Flammarion's presence it was obvious that there must be no bandying of empty compliments; no presumption upon a short acquaintance, no departure from the utmost gravity; no congratulations upon good fortune, be they ever so sincere and free from envy.

It must have been a strange scene as the leonine Flammarion, gravid with thought, conducted us round his beautiful and artistic home; through the inscribed monumental gateway opening out of the seventh of the great national roads of France; along corridors with the names of great astronomers and philosophers in ornamental writing on the friezes, and into rooms with the signs of the zodiac and other literary and scientific emblems brilliantly emblazoned on the ceilings or carved on the fitments; introducing us unostentatiously to his treasures with a minimum of words and much less than the usual amount of gesture. Probably to another visitor silence might have been more impressive than actual words, but to me, familiar with that brilliant literary style and fecund imagination which never failed in any of his works, Flammarion's grave taciturnity and his deceptive air of languid indifference were distinctly disappointing, offering great contrast to the eager vivacity of Mme. Flammarion. Subsequent private correspondence with Flammarion has demonstrated the imperfect justice of those impressions, revealing a warm and sympathetic nature which a brief acquaintance refused to discover in him personally.

Whilst Flammarion was a man of many activities, the facts of his astronomical life are few and simple. Born in 1842, his first acquaintance with astronomy dated back to the annular eclipse of the sun on October 9, 1847. At fifteen years of age he was apprenticed to an engraver, and a year later wrote a MS. of 500 pages entitled "Cosmologie universelle," from which later emerged his "World before the Creation of Man." In 1858 he entered the Paris Observatory as a computer, but found under the austere rule of the great Le Verrier little play for his fertile imagination. Leaving the Observatory in 1862, he was immediately welcomed by the Bureau des Longitudes, where he was engaged for three years, presumably in computing work. At the age of twenty-one we find him editing the scientific review *Cosmos*, and in 1864 he commenced the publication of his "Annuaire astronomique," an almanac and astronomical review of unique type, which has now appeared regularly for sixty years. In 1867, Flammarion was recalled to the Paris Observatory by Le Verrier, and placed in charge of one of the largest telescopes for the measurement of double stars. In 1887, Flammarion's review *L'Astronomie* became merged in the monthly bulletin of the Société Astronomique de France, and it is only a few years ago that the original name was restored

In June 1922, Flammarion's eightieth birthday was commemorated by an immense meeting of his admirers in the great hall of the Sorbonne, Prince Bonaparte presiding in the presence of M. Painlevé Shortly afterwards Flammarion received one of the greatest honours France has to bestow on a living subject. a commandership of the Legion of Honour.

WILLIAM PORTHOUSE.

THE death on May 26 of Lieut.-Commander Henry Edward O'Neill, R.N., removes one of the last survivors of the pioneer explorers of tropical Africa. Born in 1848, he entered the Navy in 1862 and first saw service in the operations for the suppression of the slave trade on the east coast of Africa. Soon after his appointment in 1879 as British Consul at Mozambique, O'Neill began a series of important explorations between the coast and Lake Nyassa and in the valley of the Shiré river. In five years he completed more than a dozen important journeys and discovered Lakes Amaramba and Chiuta and a new route from Blantyre to the coast. His careful observations of the position of Blantyre made it for long the best fixed position in that part of Africa. In 1885 he was awarded the Patron's medal of the Royal Geographical Society. He was associated with Captain (now Sir Frederick) Lugard in his early work against the slave raiders, and in 1888 distinguished himself in the defence of Karonga, on Lake Nyassa. On his health giving way he was compelled to leave Africa. For a time he was consul at Leghorn and at Rouen, and he retired from the service in 1899. His publications were mainly in the Proceedings of the Royal Geographical Society.

WE regret to announce the following deaths:

Mr. T. S. Brandegee, honorary curator of the herbarium of the University of California, on April 7, aged eighty-two years.

Prof. Heinrich Müller-Breslau, professor of statics and building construction at the Technical High School of Charlottenburg—Berlin since 1888, and a fellow of the Berlin Academy of Sciences, on April 23, aged seventy-three years.

Current Topics and Events.

AT the invitation of Mr. L. S. Amery, Secretary of State for the Colonies, a number of scientific men and others interested in scientific exploration visited H.M. Dockyard, Portsmouth, on Saturday last to inspect the Royal Research Ship *Discovery*, on the occasion of the commissioning of the ship for employment in scientific research in south polar regions. The visitors were taken from London by special train direct to the South Railway Jetty in the Dockyard, where the *Discovery* is berthed Much interest was shown in the scientific equipment of the ship and in the laboratory and other accommodation. Shortly after noon, Mrs. Amery hoisted the blue ensign of the Falkland Islands, to show that the *Discovery* had been commissioned, and simultaneously the expedition flag was run up After the ceremony, the party adjourned to Portsmouth Town Hall, where luncheon was provided. Mr Amery, who presided, in proposing the toast of "The *Discovery* Expedition," referred to the steps taken by the Colonial Office to mark off a zone in the Antarctic as definitely under British control, in order to preserve whales in those waters. New Zealand has also established control over a corresponding section in the Ross Sea. The work to be carried out during the expedition is outlined in an article which appears elsewhere in this issue Every arrangement seems to have been made to ensure the comfort of the members of the expedition and facilitate scientific investigation in many fields We believe that this is the first time that a vessel has been described as a "Royal Research Ship," and we hope that it may be followed in due course by other vessels similarly equipped for oceanographic investigations. We cannot be otherwise than grateful that the conditions under which work will be carried on in the *Discovery* are so different from those afforded to Huxley when he went to Australian waters in the *Rattlesnake* nearly eighty years ago.

IN his discourse at the Royal Institution, on Friday June 12, on Faraday as a chemist, Sir William Pope reminded his hearers that Faraday devoted his life to experimental research in chemistry and physics in the Royal Institution, and, at his death in 1867, he was mourned as one of the greatest natural philosophers of the early part of the nineteenth century. Faraday made his advent as a scientific investigator at a moment when striking advances in chemistry were imminent and were indeed to be foreseen; the work of his immediate predecessors, Lavoisier, Davy, Dalton, Berzelius, and Avogadro, had made of chemistry an exact science, and such a genius as Faraday was needed for the development of experimental methods. He worked on a variety of chemical subjects for several years, and on June 16, 1825, laid before the Royal Society the results of his study of the liquid deposited from compressed oil gas, in the course of which he had discovered the compound of carbon and hydrogen now known as benzene. At this centenary of his discovery we celebrate the anniversary of the initiation of a large branch of organic chemistry which in later years became of great scientific importance and, in addition, became the foundation of the several vast industries. Among these latter are to be numbered not only the manufacture of coal-tar dyes but also important sections of the pharmaceutical, photographic, and petroleum industries. Faraday was the first to make a quantitative study of the chemical changes which result from electrical action, and discovered certain electrochemical laws which are of profound chemical significance. He also carried on numerous investigations on optical glass, steel alloys, the transparency of very thin sheets of gold, and the so-called colloidal solutions of metallic gold in water.

ON June 16, the centenary of Faraday's discovery of benzene was celebrated at a full gathering in the historic lecture-theatre of the Royal Institution. His Grace the Duke of Northumberland presided, and in his opening remarks directed the attention of the rising generation to the motives which had inspired Faraday's life, to his profound trust in facts of observation and to his scientific use of the imagination. Although manufacturers have come to recognise the value of such work as Faraday's, in government circles there is still failure to link up scientific methods and discoveries with the public service. His Grace then presented diplomas of honorary membership of the Royal Institution to Prof. E Bertrand (Paris), Prof E. Cohen (Utrecht), Prince Ginori-Conti (Italy) (through his representative Dr. G A Nasini), Prof. J. F. Norris (Boston), and Prof G Sakurai (through Prof. M Katayama), who were introduced individually by Sir Arthur Keith, secretary of the Institution Appreciations of Faraday's work were delivered by Prof. H. E. Armstrong, who dealt mainly with the organic chemical aspect, and Prof. Ernst Cohen, who spoke as a physical chemist. Prof. Armstrong stated that the committee organising the celebration had decided to award at intervals—perhaps sexennially—a medal for conspicuous achievement having some relation to Faraday's discovery of benzene. The first award would be made to Mr. James Morton, of Grangemouth, for distinguished work in connexion with the manufacture and applications of anthracene dyestuffs.

FOREIGN delegates of scientific societies were then received by the president of the Royal Institution, the list (a long one) including Prof E. Bertrand, who read an address, and M Paul Kestner (France), Profs. J. F. Norris and E Bartow, Dr. Trowbridge (U.S.A.), Prof. F. Swarts (Belgium), Profs. von Romburgh and E. Cohen (Holland), Dr. Schedler (Switzerland), Prof. M. Katayama (Japan), Dr. G. A. Nasini (Italy). An address was also received from Finland, and Sir William Pope represented the federated chemical societies of Spain. The home societies sending representatives and addresses were the Royal Society (Prof. J. F. Thorpe), Chemical Society (Sir William Pope), Society of Chemical Industry (Mr. W. J. U. Woolcock), Association of British Chemical Manufacturers (Mr. J. Milne Watson), Society of Dyers and Colourists (Mr. E. Hickson),

Faraday Society (Prof. F G. Donnan). Congratulatory messages were received from the Institute of Chemistry, Indian Chemical Society, various South African societies, Australian Chemical Institute, and (the youngest society) the Auckland Chemical Society. In conclusion, Lord Balfour paid an eloquent tribute to the memory of Faraday, praising in particular his theoretical views on the constitution of the material universe, and expressing his conviction that work of the kind done by Faraday is of far greater value to humanity than the transient labours of the politician In conclusion, His Grace the Duke of Newcastle thanked the delegates for their presence and for the addresses presented, and Prof H E Armstrong for his work as chairman of the organising committee

REPLYING in the House of Commons on June 10 to a question as to large scale schemes for eliminating tsetse-flies from British possessions in Africa, Mr Ormsby-Gore, Under-Secretary of State for the Colonies, drew a necessary distinction between two different proposals While both schemes are directed towards the early removal of the menace of trypanosomiasis, now overshadowing vast areas of tropical Africa, they are different in scope To the contemplated international scientific expedition to Uganda, recommended by the International Conference on Sleeping Sickness, held in London last month under the auspices of the League of Nations, we hope to return at an early date The other project is in no way connected with the League of Nations, but owes much to the energy and enthusiasm of Mr. Ormsby-Gore himself, as shown by the recent Report of the East African Commission, which, under his leadership, visited the British East African Dependencies in the autumn of last year Briefly stated, what is proposed is to stimulate public interest, and hasten the control of sleeping sickness, and the no less important *nagana* of domestic animals, by speeding up and reinforcing existing methods of attacking the tsetse-fly carriers of these diseases To this end, it is hoped that it may prove possible to arrange for the appointment of a commission of experts, which shall proceed to tropical Africa for the purpose of undertaking (*a*) complete surveys of all tsetse areas, (*b*) further research into the bionomics of tsetse, including the factors controlling increase or decrease, and (*c*) experiments on a field scale in exterminating these flies. Provided that, pending the issue of the findings of such a commission, the work of which must necessarily be protracted, local governments continue to press forward existing methods of attack, the scheme merits cordial welcome and support.

THE subject of tsetse-fly control received further attention at a meeting of the second Imperial Entomological Conference, held in the rooms of the Geological Society, Burlington House, on the morning of June 15, when the chair was taken appropriately by Mr. Ormsby-Gore. On this occasion a valuable paper entitled "Co-ordination of Effort in Tsetse-fly Investigations" was read by Prof. Warrington Yorke, of the Liverpool School of Tropical Medicine, whose position as one of the foremost authorities on sleeping sickness is universally recognised. Prof. Yorke appealed for organisation to ensure continuity and co-ordination of work, and gave details of an interesting experiment in game exclusion, with reference to its effect upon the local tsetse-fly, *Glossina tachinoides*, now being conducted by Dr. Ll. Lloyd in a small area in Northern Nigeria. In the subsequent discussion, which was both interesting and animated, a number of leading workers on the subject took part, including Dr Andrew Balfour, Dr. A. G. Bagshawe, Prof. Robert Newstead, Dr. Guy Marshall, Major E. E. Austen, Mr. C. F M Swynnerton, Mr. D. W. Scotland, and the chairman

SIR RAY LANKESTER and Dr. J. W. L. Glaisher were both elected into the Royal Society on the same day, namely, June 3, 1875, so that they have both completed fifty years of fellowship. We understand that the council of the Royal Society has offered congratulations to each of them on their long association with the Society They are the two senior fellows of the Society next to Sir W. Boyd Dawkins, who was elected in 1867. Sir Ray Lankester received the Copley Medal in 1913, and it is a curious coincidence that in the same year the Sylvester Medal was given to Dr. Glaisher, and hence zoology and mathematics were again through this circumstance in couple Moreover, they were both at St. Paul's School together At the time of their respective elections Sir Ray was a fellow and lecturer of Exeter College, Oxford, while Dr Glaisher was an assistant tutor and examiner in Trinity College, Cambridge. Apart from Sir Ray Lankester's special scientific researches, and not least, those researches which he has inspired in others, and of which he has witnessed the fruition, he has the brilliant gift of literary expression, and has used it to supply the so-called "man in the street" with highly instructive and informative popular descriptions of natural objects and phenomena without loss of scientific dignity. He never, indeed, pandered to the purveyor of "marvels" We may recall that Sir Ray was Director of the Natural History Departments of the British Museum, 1898-1908. He is a corresponding member of the Paris Academy of Sciences, of the Reale Accademia dei Lincei, Rome, and of the U.S. National Academy of Sciences. Dr. Glaisher is a fellow of Trinity College, Cambridge. In his own department of pure mathematics he has done work of supreme value.

THE announcement has been made by foreign correspondents of the daily papers that Prof. Walther Nernst is reported to have communicated to the Berlin Academy of Sciences an account of the discovery of two new elements. It is stated that the new elements have been detected chemically and spectroscopically in several minerals and notably in platinum ores, and that their atomic numbers are 43 and 75. They have been named "masurium" and "rhenium," after the names of the East Prussian borderland and the Rhine respectively. At the time of writing, no details of the methods employed are available and it is impossible to assess the value or importance of the discovery. The new elements

would fall in Group VII. of the Periodic Classification and in a family of which only one member, manganese, has hitherto been known

THOUGH there were railways long before the Stockton and Darlington Railway and many locomotives before Stephenson's *Locomotion*, the Stockton and Darlington was the first public line and the *Locomotion* the first passenger engine. Newcomen's steam engine owed its birth to the demand of the mines for an efficient pump, and it was in the mines the railway and the locomotive were first developed. The Darlington to Stockton line as originally projected by Edward Pease in 1817 was chiefly for the conveyance of coal to the sea-board, and it was due to the advice of George Stephenson in 1823 that powers were obtained for carrying passengers This pioneer line was opened in September 27, 1825, when Stephenson's famous engine *Locomotion*, driven by Stephenson himself, drew a train of 34 vehicles with 450 passengers from Darlington to Stockton Thus was inaugurated the tremendous passenger traffic of to-day. The centenary of this event is being celebrated on an appropriate scale, and on July 1 the Duke of York is opening an exhibition at Darlington. On the following day, *Locomotion* will again be put under steam and will haul a replica of the original train along the line There is also to be a procession of rolling stock The celebration has been advanced from September to July on account of the meeting in London during the last week in June of the International Railway Congress Some 800 delegates representing the railways of the world are attending the Congress, and after the various meetings in London and the district the delegates will proceed to Darlington, when the procession of old and modern locomotives and rolling stock will be repeated. The members of the Institution of Mechanical Engineers will also take a part in the celebration Stephenson was the first president of the Institution, and the summer meeting is therefore to be held at Newcastle while the centenary celebrations are in progress.

IN the colonial possessions of Great Britain and France the same problems of malaria and sleeping sickness are encountered. British workers are well acquainted with the conditions in their own colonies, but often little is known of those which prevail in the colonies of our neighbours. The two lectures delivered by Prof. Émile Brumpt, of the Faculty of Medicine of Paris, on behalf of the Chadwick Trust, have afforded to medical men in England an opportunity of hearing the views of a distinguished Frenchman on the question of prophylaxis against these two diseases. As was to be expected, the plans of a campaign as outlined by Prof. Brumpt are the same in whatever country it is undertaken, but the instructive series of lantern slides, the outcome of recent tours made by him, illustrated the conditions which conduce to the spread and persistence of malaria and sleeping sickness in countries which rarely come into the experience of British workers. In this respect the lectures were of value in showing that, though the fundamental principles of prophylaxis are always the same, they have to be applied with due regard to the local features of the country and the habits of the natives. Not only is it necessary for the medical officer to have a good knowledge of the diseases themselves and the parasites which cause them, but he must also understand the bionomics of the insect vectors, which vary with the localities to be dealt with, and, above all, he must be able to modify, extend, and adapt the measures to meet ever-varying contingencies. It results that a sound training in the methods of prophylaxis in all its aspects is a *sine qua non* of success Furthermore, the control of these diseases is an undertaking which must be made by all the colonising nations working to the same end. Progress made in one colony would be very largely frustrated if the diseases were allowed to run riot in an adjoining territory In this direction of co-operative endeavour the Health Section of the League of Nations has undertaken the arrangement of an international commission to investigate certain problems connected with the spread of sleeping sickness in Africa, with the view of furnishing information which will be of value to all those nations which are attempting to stamp out the disease.

A BRILLIANT spell of fine summer weather has occurred generally over England, and in the southern and midland districts some unusually high temperatures for June have been experienced. The burst of heat set in on Wednesday, June 3, with a shade reading of 73° at Greenwich and a temperature above 150° in the sun's rays. On Saturday, June 6, the shade temperature was 84°, and the mean temperature for the 24 hours was 11° in excess of the normal. The highest temperature in London at the time of writing was on Thursday, June 11, when 87° was registered at Greenwich, which, however, was beaten for the corresponding day by 2° in 1900, when 89° was registered. A temperature of 90° was registered at Greenwich on May 22 and 24, 1922, which is the highest temperature on record to June 15 since 1841. During the 84 years from 1841–1924, the absolute maximum temperature for the several days in June has occurred on 55 per cent of the days in the 28 years 1841–68, on 20 per cent in the 28 years 1869–96, and on 25 per cent. in the 28 years 1897–1924. To Saturday or Sunday, June 13 or 14, there were at several places in the south of England 14 consecutive days without rain, which constitutes a drought. Brilliant sunshine was an exceptional feature in the southern and midland districts.

THE recently issued report of the Empire Cotton Growing Corporation for the year ending on March 31 still shows an excess of income over expenditure, but one which is being steadily diminished, as that body is gradually, through its training of men at the universities and elsewhere, overcoming the great difficulty of providing officers with the necessary technical training to assist in the development of cotton overseas. Nineteen men have now been trained, of whom all but two have received appointments. For the present year, as for last, an unlimited number of studentships is offered to those

who are thoroughly qualified. A grant of 3000*l.* a year is being made to assist in the maintenance of experimental farms in Australia, a plant breeder has been sent to Southern Rhodesia, and another to the Sudan, while, in conjunction with other bodies, funds have been provided for the erection of ginneries in Southern Rhodesia. Many other lines of work are also being commenced. At the present time the production of good cotton within the British Empire is progressing steadily, and is expected to reach 350,000 bales in the coming season There is no sign yet that the top of the curve is in sight, but much sustained and careful work along scientific lines will be necessary to maintain this development, and to carry it to the point of imperial independence in cotton supply

At a meeting on June 9, the Illuminating Engineering Society, in co-operation with other bodies interested, held a discussion on "Natural and Artificial Sunlight in Health and Disease" Dr. Saleeby, who opened the discussion, gave an excellent review of this problem, which interests engineers, architects, and medical men alike There were on view a great variety of special lamps devised to furnish "artificial sunlight." As one of the speakers pointed out, this description is not quite accurate Nevertheless there is no reason to doubt that such lamps can supplement natural sunlight, with very good results, in medical treatment. Although there has been remarkable gain in our knowledge of effects of light on the human body during recent years, there is much in connexion with the ultra-violet rays, their merits and limitations, that is still obscure. Therefore the view expressed at the meeting that this is essentially a scientific problem, and that such forms of energy should not be applied indiscriminately nor regarded as a panacea for all ills, deserves emphasis. About the general value of sunlight in relation to health there can be little doubt, and every encouragement should be given to efforts to free the atmosphere of our cities from the pollution of smoke from wasteful coal fires. The meeting was a very representative one, and the Society has done good service in bringing together those interested in various aspects of the subject.

The Council of the British Cast Iron Research Association has recently extended its research programme by arranging for an investigation on the influence of silicon, manganese, and phosphorus on the formation of graphite in cast iron, to be conducted by Mr. M. L. Becker at the University of Manchester, under the supervision of Prof F. C. Thompson, and for an investigation to be commenced at the National Physical Laboratory, under the supervision of Dr. W. Rosenhain, on the alloy systems iron-silicon, iron-manganese, iron-phosphorus in the presence of carbon over the range usually associated with cast iron. It is anticipated that these fundamental investigations will yield information of great value in connexion with other investigations in hand. The Director and Consultant of the Association are now visiting Continental laboratories and works for the purpose of examining recent foundry developments, particularly in Germany.

At the anniversary meeting of the Linnean Society on May 26, the Society's Linnean medal in gold, its highest award, was presented to Prof. Francis Wall Oliver, professor of botany in the University of London at University College since 1888, when he succeeded his father, Daniel Oliver, in the chair. In presenting the Medal, reference was made to Prof. Oliver's distinguished services,—his work on the fossil Pteridosperms; on the survey of British vegetation, which resulted later in the establishment of the British Ecological Society; his early observations on tidal problems of vegetation at the Bouche d'Erquy in Brittany, followed by the permanent station at Blakeney Point in Norfolk, now the property of the National Trust, under the conditions of the natural flora and fauna being preserved The Medal has been given in alternate years to a botanist and a zoologist since its institution in 1888, when the centenary of the Society was celebrated.

A climatological congress, arranged by the Davos Institute for Alpine Physiology and Tuberculosis Research, will be held at Davos on August 17-22. Full particulars can be had from the Institute.

At the anniversary meeting of the Linnean Society the following officers were elected:—*President*, Dr. A B. Rendle; *Treasurer*, Mr. H. W. Monckton; *Secretaries*, Dr. B. Daydon Jackson (General), Dr. W. T. Calman (Zoology), and Mr. J. Ramsbottom (Botany).

Dr E F. Armstrong, of the British Dyestuffs Corporation, Ltd., and Mr. H. Sutcliffe Smith, of the Bradford Dyers' Association, have been appointed members of the Dyestuffs Industry Development Committee set up under subsection 2 (6) of the Dyestuffs (Import Regulation) Act, 1920, in succession to Sir William Alexander and Mr. G. Douglas, resigned.

At the annual general meeting of the Royal Geographical Society on June 15, the following officers for the ensuing year were elected:—*President*, Dr. D. G Hogarth; *Vice-Presidents*, Sir Charles Close, Prof. J. Norman Collie, Maj.-Gen. Lord Edward Gleichen, Sir Sidney Harmer, Sir John Scott Keltie, Sir Francis Younghusband; *Treasurer*, Lord Biddulph; *Trustees*, Mr. Douglas W. Freshfield, Lord Ronaldshay; *Hon. Secretaries*, Mr. A. P. Maudslay, Col.-Com. E. M. Jack; *Foreign Secretary*, Sir Maurice E. de Bunsen.

On Friday, June 26, Viscount Grey of Fallodon will make a presentation to Dr. G. Claridge Druce on behalf of the Botanical Society and Exchange Club of the British Isles, at Dorchester House, Park Lane, London, which has kindly been lent by Sir George and Lady Holford. Particulars of the meeting can be obtained from the Hon. Mrs. Adeane, 1 Dean Trench Street, Westminster.

The fourteenth International Geological Congress is to be held in Madrid during May and June 1926. The provisional list of subjects for general discussion includes the following topics: The world's reserves of phosphates and pyrites, geology of the Mediterranean and of Africa, Cambrian and Silurian faunas, Tertiary vertebrates and foraminifera, Hercynian

folds, modern theories of metallogeny, vulcanism, and the application of geophysical studies to geology Excursions covering a wide range of interests are being arranged. The general secretary for the Congress is Señor E. Dupuy de Lôme, Geological Institute of Spain, Plaza de los Mostenses 2, Madrid.

THE Albert Medal of the Royal Society of Arts for the current year has been awarded by the Council, with the approval of the president, H.R H the Duke of Connaught, to Lieut.-Colonel Sir David Prain, "for the application of botany to the development of the raw materials of the Empire." Sir David is one of the most distinguished of living botanists When Director of the Royal Botanic Gardens at Calcutta he developed the Government cinchona plantations of India, and organised a system for the cheap distribution of quinine through the post offices, thereby making the drug familiar in every village of India and saving unnumbered human lives. Afterwards, as Director of the Royal Botanic Gardens at Kew, his work was of great scientific importance and of great value to those engaged in the timber and plant products industries

THE Faraday Society will hold a general discussion on "Photochemical Reactions in Liquids and Gases" at Oxford on October 1-2 next The subject will be discussed under two main heads. (1) Einstein's Law of Photochemical Equivalence, (2) the Mechanism of Photochemical Reactions. Part 1 will be opened by Prof A. J Allmand (King's College, London) and Part 2 by Prof. M Bodenstein (Berlin) In addition to the leading English workers on photochemical action, many distinguished investigators from the continent and the United States have signified their intention of taking part in the proceedings, and an attractive programme of papers has been prepared. It is hoped to accommodate all who attend the meeting at Exeter College and Lincoln College. Non-members of the Faraday Society may attend the meeting, and those desirous of doing so are asked to communicate at once with the Secretary of the Faraday Society at 90 Great Russell Street, London, W.C 1, from whom full particulars may be obtained

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Head of the engineering department of the Swindon and North Wilts Technical Institution—The Principal (June 24) A lecturer in electrical engineering at the Municipal Technical College, Swansea—The Director of Education, Dynevor Place, Swansea (June 24) A research worker in the Department of Scientific and Industrial Research, on adhesives—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W 1 (June 27) An assistant lecturer in mathematics at the Municipal College of Technology, Belfast—The Director of Education, Belfast (June 29) A junior assistant in the Information Bureau of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (July 4) A junior assistant in the metallurgy department of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (July 4) A lecturer in physics and mathematics at the Northampton Polytechnic Institute—The Principal, St John Street, E C 1 (July 6) A lecturer in physics in the University of Durham (Durham Division)—The Head of the Department of Pure Science, South Road, Durham (July 11) A junior assistant (physics) at the Shirley Institute, British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (July 15). A lecturer in zoology, with special reference to cytology and experimental zoology, in Edinburgh University—The Secretary (July 23). A lecturer in biology at the Cheshire School of Agriculture—The Principal, Reaseheath, Nantwich. An evening lecturer in bacteriology at Battersea Polytechnic—The Principal.

Our Astronomical Column.

COMET TEMPEL (2).—Information has been received from the International Astronomical Union Bureau at Copenhagen that this comet has been detected by Mr. Stobbe (observatory not stated), as follows:

	G.M.T. (?)	R.A.	N. Decl.
June 11	$23^h\ 42{\cdot}0^m$	$18^h\ 23^m\ 28^s$	0° 13′

The magnitude is stated as 12·0, which is fainter than anticipated, and hence explains why it has not been found by the several observers in England who have looked for it. It is approaching the earth and the sun and should brighten considerably. The perihelion date will be about August 7·6, which is within two days of the anticipated date. The following are two predicted places (approximate) for midnight (0 hr.)

	R.A.	S. Decl.
June 18	$18^h\ 25\ 8^m$	0° 46′
,, 26	$18^h\ 28\ 7^m$	2° 55′

PROVISIONAL SOLAR-CONSTANT VALUES.—Vol. 77, No. 3 of the Smithsonian Miscellaneous Collections contains provisional solar-constant values for the period August 1920-November 1924, together with monthly and decade means from 1918. It is stated by the compilers, Dr. C. G. Abbot and his colleagues, that they would have preferred not to make public any provisional values at present, as the variation of the sun is seldom large and there is a great difficulty in maintaining a sufficiently high standard of accuracy in the solar measurements to give the magnitudes of the changes very closely. Owing, however, to the growing interest in the "variable" nature of the sun's output in radiation and its promise of usefulness in connexion with weather reports for the study of the dependence of weather and climates on these variations, the demands for the observations have been so insistent that the authors now "publish briefly at this time the best knowledge we now have" The reader is, however, given to understand that small modifications will probably be made in the final publication, which they hope to make in Volume V of the Annals of the Astrophysical Observatory.

Table I., covering 25 pages, gives a summary of the results from Mt. Harqua Hala and Montezuma, while Table III. gives the decade and monthly mean solar-constant values 1918 to 1924. Several interesting curves are given, one of which shows that increased solar activity brings higher solar-constant values.

Research Items.

THE RELIGION OF THE PRIMITIVE HUNTER.—In the *Sociological Review* for April, Mr. Christopher Dawson, in a communication on "Religion and Primitive Culture," argues that the remarkable resemblances in the "hunting cultures" of North America and Siberia, Australia and South Africa, to the culture of palæolithic Europe are too great to be fortuitous. They have a common religious foundation, a common attitude to life which may be called the "religion of the hunter." The fact that totemism extends from West Africa to North America, and was one of the constituent elements in predynastic culture in Egypt, is fatal to the claim of Australia to be the home and centre of diffusion of totemism as held by some writers, and makes it difficult to believe with Prof. Elliot Smith and his school that it was diffused by the historic Egyptians of the "Archaic Civilisation." Judging by the North American evidence, it seems clear that the religion of the hunter—the belief in animal guardian spirits—lies at the root of the whole development. First came the guardian spirit of the Shaman; then of the individual, and as population increased and the group became more complex, the same idea became the principle of the social organisation, on one side of the secret society with a common guardian spirit, on the other of the totemic clan, a group of kinsmen inheriting a common guardian spirit.

THE MAGIC OF COLOUR.—Mr. Stewart Culin, in a lecture delivered to the Textile Color Card Association of New York in February last, which is published in the *Brooklyn Museum Quarterly*, vol. 12, No. 2, describes some of the magical beliefs relating to colour, especially in China and Japan. The significance of colour with the fundamental associations, which have come down to our own day, was established when a belief in magic was universal. This applied in five directions, the seasons, the elements, the planets, the points of the compass, and the notes in the musical scale. In an old Korean book in Mr. Culin's possession, the musical notes are indicated in colour. The Chinese flags of the Manchu bannermen, green, red, white, black, and yellow, correspond with the east, south, west, north, and middle. Red is the colour for expelling demons and preponderates in the garments of European peasants, and this colour is used in the placards which the Chinese paste on their doors at the New Year. Yellow was the colour of the middle, of the element earth, of Saturn, of gold, of the grain rice, and of the emperor. Colour determined the value of gold, of precious stones, and turquoise and jade. In Japan colour flourished chiefly in Buddhist ceremonial and in the Imperial court, but the accessories of Shinto are without colour, and the Japanese of to-day dislike Chinese colour.

THE BLUE WHALE.—Sir Sidney Harmer (Proc. Zool. Soc., 1923, p. 1085) contributes some interesting observations on two enormous cervical vertebræ of the blue whale, found in the Panama Canal Region and presented to the British Museum by Mr. F. Mitchell-Hedges. These vertebræ had the epiphyses completely fused, and this fact, coupled with their large size, when compared with available evidence from other specimens, bears out the original estimated length of the specimen of ninety-eight feet. This would appear to establish the fact that the northern blue whale may grow to at least one hundred feet, and that there is no substantial basis for the suggestion that the southern race of this whale is larger than the northern. As the blue whale is considered an ice-loving species, this record from the tropics is of considerable interest from that point of view, as well as from its bearing on the possibility of a migration across the equator of blue whales from the northern to the southern hemisphere, and vice versa. Further evidence of the size at which the epiphyses in this whale become ankylosed is supplied by Sir Sidney in Proc. Zool. Soc., 1924, p. 1175. In the southern race of the whale specimens measuring eighty-four feet were found to have the epiphyses free, while in one of ninety-one feet they were fully ankylosed.

BEAKED WHALES.—In Proc. Zool. Soc., 1924, p. 541, Sir Sidney Harmer reviews the genus Mesoplodon, with special reference to *M. mirus* and *M. densirostris*, and discusses the cranial characters of the beaked whales in general, with a valuable criticism of the importance of the antorbital region of the skull as a valuable character for purposes of classification. He rejects the genus Paikea of Oliver as instituted on insufficient grounds, and includes it as a synonym of Mesoplodon. Detailed descriptions of two skeletons of *M. mirus* from the coasts of Ireland (two out of the only three known specimens) and one of *M. densirostris* from Madeira conclude a valuable contribution to our knowledge of Cetacea. Sir Sidney Harmer's ninth report on Cetacea stranded on the British coasts covers the years 1923–24, and, while not including any species of great rarity, several interesting records are deserving of notice. The white-beaked dolphin was more numerous than usual, and appears to be establishing its claim to be regarded, after the common porpoise, as the commonest British cetacean. Special attention is directed to the record of the false killer (*Pseudorca crassidens*) in a sub-fossil condition in the Cambridgeshire Fens, and to the unexplained occurrence of vertebræ of three large rorquals (two blue whales and one common rorqual) off Newhaven, Sussex.

MOSQUITO CONTROL.—The International Health Board of the Rockefeller Foundation has issued a very valuable pamphlet on "The Use of Fish for Mosquito Control." It includes a brief historical survey of the matter, a very complete summary of the work which has been accomplished in all parts of the world, with illustrations of the fish employed, and a general statement of the biological principles on which the control of mosquitoes by fish is based. Special attention is given to the requirements of fish as mosquito destroyers, and to the conditions under which they may be successfully used for this purpose, emphasis being laid on the use of indigenous species where possible. It is intended mainly for the use of the field staff of the Board, but has obviously a wider field of interest, and the biologist particularly will welcome this full statement of the results which have led to the elaboration of this method of controlling yellow fever and malaria, and to its successful establishment in various parts of the world.

A NEW PROLIFERATING LARVAL TAPEWORM.—B. Schwartz describes (Proc. U.S. Nat. Mus., vol. 68, art. 24, 1924) cysticerci, which he refers to a new species of Tænia, from the lung of an Alaskan porcupine (*Erethizon epixanthum*). The cysticerci occur singly or in colonies; in the latter case the basal stalks or peduncles issue from larger stalks which are in the lung tissue. The scolex has four elliptical suckers and a double row of hooks—18 large and 18 small.

MYCETOZOA OR "POLYANGIDÆ."—Roland Thaxter in 1892 first described as Myxobacteria, primitive minute organisms which in the vegetative state, though retaining their separate individuality, radiated outwards as they multiplied on the substratum, as a slimy plasmodium-like mass. As their name suggested, Thaxter thought the individual organisms, multiplying probably by transverse fission, were allied to the bacteria, the whole mass in its slimy aggregate recalled the plasmodium of the Myxomycetes (or Mycetozoa). Jahn has recently reclassified the group, adding new forms that he has first described ("Beiträge zur botanischen Protistologie." 1. Die Polyangiden. Leipzig: Gebrüder Borntraeger, 1924. 10*s.* 6*d.*), and, not satisfied with the affinities suggested by Thaxter's name for the group, rechristens them the Polyangidæ, after the generic name under which a species of the group was first recorded (in 1809). Thirty-six species are now described under eleven genera, which are grouped in four families. The systematic characters are mainly based upon the form and structure of the very small, but sometimes very striking fruit bodies, into which the slimy mass of microscopic organisms aggregate themselves under suitable conditions, though the family regarded by Jahn as most primitive only heaps into irregular masses, never forming definite cysts.

STARCH AND OTHER CELL-CONTENTS.—The Mémoires de la Société Royale des Sciences de Bohême for 1923, published at Prague (1924), contains a number of papers, mainly mathematical and botanical, they are written in Czech or German and followed by a summary in French or English. Several botanical papers are systematic or ecological in nature. In addition, W. S. Iljin describes further experiments dealing with the effects of salts upon the hydrolysis of starch (NATURE, September 15, 1923, p. 407). Sodium chloride in concentrations from 0·05 M to 0·1 M causes the hydrolysis of the starch in the guard cell of stomata in many plants, but in the case of halophytes much higher concentrations are necessary. Vegetable cells placed in dilute solutions of maltose synthesise starch energetically, but the process is stopped by the addition of sodium chloride or other salts to the solution. E. Votoček and V. Ettel direct attention to the ease with which galactose yields a crystalline dibromo, 2.4-phenylhydrazone, thus permitting its quantitative separation under certain conditions from xylose, rhamnose, glucose, fructose, etc., but not unfortunately from arabinose, with which it is so often associated after hydrolysis of plant pectins.

THE FUNCTION OF NICOTINE IN THE PLANT.—J. J. Theron and J. V. Cutler have an interesting contribution to this problem, which is of both theoretical and commercial importance, in the *South African Journal of Science*, vol. 21, 1924, pp. 189-194. They show that the total nicotine content in the plant increases up to the flowering stage, after which there is a rapid decline, whilst the formation of seed immediately reduces the percentage of nicotine They conclude that the nicotine is a storage product which is drawn upon to form other nitrogen reserves within the seed. The authors also record continued metabolic change in the harvested crop which produces a considerable diminution of nitrogen and can be prevented by methods which raise the temperature of the leaves shortly after the crop is cut.

THE GEOLOGY OF THE CHATHAM ISLANDS.—Early last year the Otago Institute organised an expedition to the Chatham Islands, and a preliminary account of the geological observations has now been given by R. S. Allan in the *New Zealand Journal of Science and Technology* (Feb. 1925, p. 290). The Islands consist structurally of a series of faulted blocks which in the late Pliocene were relatively elevated or depressed to different levels, and have since been eroded, and linked up by immense sand banks and spits. The most southerly block of the main island now rises to nearly 1000 feet and ends suddenly in a magnificent line of basaltic cliffs up to 700 feet in height. The northern part of the island is low-lying and swampy, but here the oldest rocks, quartz-mica-schists striking approximately east and west, are exposed along the shores. Lithologically these schists resemble those of Otago, but the comparison throws no light on their age, as the Otago schists themselves have been referred to various periods from the early Palæozoic to the early Mesozoic. Lying on the foundation stones of the Islands with great unconformability are Bryozoan limestones and limburgite-tuffs of Oligocene age. Unconformably on these are Middle Pliocene sands and grits containing a fauna, 63 per cent of which is identical with that of corresponding age in New Zealand. The Oligocene limestones, in striking contrast, have only 4 per cent. of the species in common. The volcanic rocks are of great interest and are referred to two main epochs of eruption. The earlier series (Oligocene) consists solely of tuffs and flows of limburgite. The later series (younger than the Oligocene and older than the late-Pliocene or Pleistocene fault-movements) is mainly made up of basalts, but associated with the predominant type are mica-andesite, trachyte, and phonolites.

ORIGIN OF PLATINUM AND GOLD NUGGETS.—Detailed physico-chemical analyses of platinum nuggets have enabled Prof S. F. Zhemchuzhny (*Ann. Inst. d'analyse physico-chimique de l'Acad de Science de Russie*, vol 1, liv. 2) to come to the conclusion that the nuggets do not differ in their structure from alloys. Certain details of structure, as well as the presence within the mass of platinum of crystals of osmic iridium and of small round cavities, corresponding to bubbles of air, show that platinum has crystallised from the magma in which it has been dissolved in a molten condition Gold nuggets, according to the same author (*loc. cit* 2, liv. 1), are of a quite different origin, their structure and physical properties indicating that they have been formed by crystallisation of gold from solutions of that metal in the water solutions of sulphur salts or of sulphates of iron oxide, which are products of oxidation of gold-containing sulphur pyrites.

THE POLAR AURORA.—Prof. L. Vegard has recently shown by means of experiments made with solidified nitrogen diluted with argon at the temperature of liquid hydrogen, that it was possible to reproduce the N_1 aurora line by bombardment with cathode rays. In collaboration with Messrs H. Kamerlingh Onnes and W H. Keesom he describes in the *C R. Acad. Sci.*, Paris, April 6, experiments in which the nitrogen was diluted with neon, and cooled with liquid helium. The N_1 band changes, when the proportion of neon is increased, in a similar manner to that observed with nitrogen and argon at the temperature of liquid hydrogen, but with a much slower displacement towards the red as the dilution is increased, the position of the principal maximum, indeed, remains nearly constant until 70 per cent. of neon is present. From this point on, the maximum commences to shift rapidly with an increase in the proportion of neon, on account of the resulting diminution in the size of the nitrogen particles. When the proportion of nitrogen has been reduced nearly to zero the N_1 band becomes a line, with wave-length 5578·6, which very nearly coincides with the green line of the aurora. The small difference is attributed to a specific action of the neon,

so that it is probable that, if similar small particles of nitrogen could be bombarded with electrons at very low temperatures without any additional substance, the auroral green line would be given out.

THE DENSITIES OF LIQUID AND GASEOUS HELIUM.—When the densities of a gas and of its liquid form, in contact with one another, are plotted against temperature, the two density curves meet at the critical temperature, the joint curve being roughly parabolic. If now the arithmetic means of the two densities at the different temperatures are plotted, the graph has been found to be nearly a straight line, which also passes through the critical point In the *C R Acad Sci*, Paris, March 30, E Matthias, C A Crommelin, H Kamerlingh Onnes, and J. C Swallow give the results of a series of measurements which verify this law of the rectilinear diameter for helium, the densities having been measured for nine temperatures ranging from 4·71° abs. down to 2·30° abs. The deviations from rectilinearity are small, but a little larger than for hydrogen and neon By means of the equations deduced it is possible to calculate the value of the critical temperature of helium $\Theta = 5\cdot19°$ abs, and the critical density $\Delta = 0\cdot06930$ The critical coefficient $R\Theta\Delta/\Pi$ is equal to 3·270, where R is the gas constant and Π the critical pressure, this is very nearly the same as for hydrogen (3·276)

DIRECTION OF RADIO SIGNALS DURING THE ECLIPSE OF JANUARY 24.—Prof Merritt communicates a paper on the changes observed in the direction of radio signals at the time of the eclipse on January 24, 1925, to the April number of the Journal of the Franklin Institute. As a part of the programme of eclipse observations at Ithaca, N.Y., records were kept during the morning hours of January 23, 24, and 25 of the apparent directions of stations at Schenectady and New York as indicated by radio direction finders Graphs are given in this paper of the results obtained The observations were begun at least an hour before sunrise, and show in a striking way the large and extremely rapid changes in direction characteristic of night conditions The time at which "day conditions" are established seems to vary largely from day to day On the day of the eclipse, the night conditions persisted until an hour after sunrise, and this although the sun had been shining brightly On the next day, which was very cloudy, day conditions were reached while it was still almost as dark as midnight It is concluded that if the observed direction changes are due to sunlight at all, they must be brought about by the changes caused by light in the upper regions of the atmosphere. Although the variations in the direction during the early hours of January 23 were much less marked than on January 24, yet there is a definite indication that night conditions persisted nearly as long on both days, although January 23, like January 25, was a very cloudy day. There is some slight evidence that persistence of night conditions after sunrise is associated with high barometric pressure and a large pressure gradient. On the day of the eclipse, night conditions persisted until half an hour after the eclipse began. Six minutes after the end of totality a systematic drift towards the south began, and for eight minutes the settings indicated that the signals were coming from a direction 15° south of the true direction of New York Thirty-five minutes after totality, the readings had become normal It is stated that if the effect is due in some way to changes in the ionic concentration resulting from changing illumination in the upper atmosphere, then the delay in the appearance of an eclipse effect until after the end of totality might have been expected.

SEPARATION OF SELENIUM AND TELLURIUM.—V Lenher and C. H. Kao describe a new method of separating selenium and tellurium in the Journal of the American Chemical Society for March. To a solution of the oxides in 100 c.c. of concentrated hydrochloric acid, 50 c.c. of acid saturated with sulphur dioxide is added. After vigorous stirring, and on standing, selenium settles out and is readily filtered off The tellurium is then obtained from the mother liquor by precipitation with sulphur dioxide and hydrazine. The temperature of the solutions should never exceed 30°.

CONDUCTIVITY IN SOLUTION AND CONSTITUTION.—The conductivities of many saturated salt solutions in liquid hydrogen sulphide at the temperature of solid carbon dioxide have recently been measured by G. N. Quam and J. A Wilkinson (Journal of the American Chemical Society, April). Many salts form conducting solutions, halides of the phosphorus family show increased conductivity with increase of atomic weight, except in the case of bismuth, which forms an insoluble compound with liquid hydrogen sulphide. The conductivity of solutions of acetic acid derivatives is higher the greater the negativity and positivity of the groups joining the compound Ammonium chloride is insoluble in the solvent; the introduction of alkyl groups in place of hydrogen causes the compound to become soluble and the solution conducts in proportion to the number of groups introduced. Pure liquid hydrogen sulphide has a conductivity less than 1×10^{-11} reciprocal ohms

A CONTINUOUS REFRIGERATOR.—Refrigerating plants may be broadly grouped into the vapour compression type and the vapour absorption type Vapour absorption machines are generally intermittent in action, since the ammonia has to be expelled by heat from a solution in one stage of the cycle and absorbed back again in a later stage. These operations necessitate the manipulation of valves. In the issue of the *Machinery Market* of May 1, there is a description of a novel method of continuous refrigeration, working on the vapour absorption system, which is the invention of two Swedish engineers, Munters and Platen, and for which they were awarded the Polhem Medal in 1924 The Munters-Platen system has no moving parts and the pressure is the same through the circuit The evaporator contains a strong solution of ammonia. At the base of the evaporator is a heater round the body of which is coiled a pipe which projects above the surface of the liquid. When heat is applied this pipe becomes so hot that the solution inside it boils, and rising, discharges water into the evaporator, the ammonia gas being liberated. The ammonia solution is drawn from an absorber into the evaporator by this novel thermo-syphon device which induces automatic circulation. The ammonia gas given off by the evaporator is passed into a condenser and liquefied. This liquid ammonia then passes into a generator, where it gasifies absorbing heat from its surroundings, thereby producing refrigeration. The ammonia gas from the generator mixes with the hydrogen filling the system. The resultant gas mixture is heavier than pure hydrogen and enters an absorber near the bottom where it meets a shower of water. The water absorbs the ammonia, and the hydrogen, denuded of the heavier ammonia gas, rises and returns to the generator, entering near the top. Thus there is an automatic circulation. The connecting pipes are so arranged as to function as heat interchangers in both the gas and the liquid circuits. The only motive force for the whole apparatus is the heating coil in the evaporator.

The Origin of Species as revealed by Vertebrate Palæontology.[1]

By Dr. HENRY FAIRFIELD OSBORN,

Senior Geologist, U S. Geological Survey; Hon. Curator Vertebrate Palæontology, American Museum of Natural History; Research Professor of Zoology, Columbia University.

I. JUST as in the inorganic world energy directs matter, not matter energy, so motion or function invariably precedes form; change of motion or function precedes change of form.[2] A static condition of form, in either the trunk, the limbs, the vertebræ, or the teeth, implies a static condition of habit, of habitat, or of function; consequently, a new habit (ontogeny), in either the unchanged or changing environment, gives rise to a new movement or function and results in change of form in the organ most directly affected. Each particular organ and each part of an organ may manifest a dependent or independent change of function and consequent change of form; thus a series of organs or of closely related or similar parts of the same organ may manifest either harmonic or disharmonic change. This principle, first observed by Aristotle, more or less developed by Lamarck, and more specifically by Cope, has been confirmed by such observations as those of Arbuthnot Lane.

II. *The principle of compensation* on economy of growth, first formulated by Aristotle and later more clearly by Geoffrey St Hilaire (*loi de balancement des organes*), whereby the increased motion or function of one organ is compensated for by diminished motion or function of another organ, is a bio-mechanical principle thoroughly established in vertebrate palæontology; not only adjacent or related organs, but organs widely separated functionally and anatomically rigidly obey this economic law, which receives its most substantial demonstration in palæontologic series. Its corollary is development and perfection through use and degeneration through disuse.

III. *The principle of continuity*, in which evolution is like growth, is one which could be discovered and observed only in palæontology, where large numbers of successive lines of descent of organisms can be observed. To our knowledge, this principle was first observed by the invertebrate palæontologist Waagen in 1869, who observed continuous change whereby a minute and inconspicuous organ gradually in geologic succession becomes so conspicuous as to constitute a stage; he named this stage a "mutation," a term now used in palæontology in a sense directly opposite to its borrowed use in botany and zoology Following the establishment of the principle of continuity by many invertebrate palæontologists came the vertebrate studies of Déperet and especially of Osborn, who in his monograph of researches on the evolution of the titanotheres[4] has firmly established this principle. Every bio-mechanical organ in every part invariably arises and evolves through a continuous process, and in this respect evolution is a forecast of ontogeny or individual development. Each new adaptive organ rises gradually and continuously out of the germ-plasm, passes into a stage of mechanical perfection, and then subsides into the germ-plasm and disappears.

IV. *The principle of germinal or evolutionary trend in a definite direction.* So far as I know, this was first expressed by the Austrian palæontologist Neumayr, who applied to this trend the term "Mutations richtung," equivalent to "trend of evolution." He applied it to just such characters of ornament, shell marking, and shell proportion as those observed by his predecessor Waagen in his "mutations" This cumulative orthogenetic trend in evolution of organs in certain definite directions is also firmly established in both invertebrate and vertebrate palæontology. It may be quite antecedent to ontogenetic habit or function and, consequently, by its independence of origin is purely germinal; it is a process resident in the heredity germ itself.

V. *The principle of acceleration and retardation.* Observed by Von Baer in embryology, this principle was formulated and elaborated in palæontology by Alpheus Hyatt, a member of this Academy. It is one of the most important principles in bio-mechanical evolution, as hurrying forward or holding back the development of organs to the exact moment when they are first needed and most needed by the organism. For example, in all hoofed animals of the plains, where the young may be required to run with the mother immediately after birth, the adult limb proportions are pressed back into the prenatal stage so that the young at birth may be able to keep pace with the mother, for a few moments at least. This bio-mechanical principle can only be explained by Darwin's selection principle operating on heritable variations.

VI. *The principle of allometry*, or change of proportion as studied by Osborn in the Titanothere Monograph.[4] Adaptation through change of proportion is the most universal principle in vertebrate evolution. It is due to three causes: (*a*) the elongated neck of the giraffe, alternately cited by Lamarck and Darwin as due to inheritance or selection, may be experimentally shown to be due to the deferred inheritance of an acquired adaptation through the coincident selection of all fluctuations in the adaptive direction. (*b*) All changes of proportion which are not caused by either habit or selection fall under the principle of "Mutations richtung" or evolutionary trend, whether observed in the shells of invertebrates or in the head form of the mammals, including man. (*c*) All changes of proportion which are influenced by habit are due to this dual mode of accumulation; by experimental adaptation in a single lifetime, *e.g.* the hind limbs of a dog with proportions of the running type are changed into hind limbs with proportions of the leaping type by the process brought about by the principles of compensation and self-adaptation

VII. *The principle of rectigradation*[5] *in adaptive organs* arising from the germ-plasm passing continuously from the most rudimentary into the most efficient and highly developed stages First observed in the Primates in 1889 by Osborn, this principle has since been confirmed in the other four great orders of mammals, the horses, rhinoceroses, titanotheres, and the proboscideans (Osborn, 1889–1911) Consequent on this principle is the "potential homology" of organs (Osborn, 1902–1911), in contrast with the true homology of Aristotle, or "genetic homogeny." For example, all the bony elements of the limb of the Tetrapoda are homologous in Aristotle's sense; all except one of the elements in the grinding teeth of the mammals are instances of potential homology rather than of genetic

[1] Continued from p. 946.

[2] See D'Arcy W. Thompson, "Growth and Form" (Cambridge, 1917), Chapter 1. See Osborn, "Origin and Evolution of Life" (New York, 1916), Introduction.

[4] H. F. Osborn, "The Titanotheres of Ancient Wyoming, Dakota, and Nebraska," United States Geological Survey Monograph, No. 55. Now in press. A sequel to the monographs of O. C. Marsh.

[5] Eimer sets forth a graduated evolution as comparable to organic growth. The conception of rectigradation as defined by Osborn is not found in Eimer's volume, nor is the word "orthogenesis" attributed to Eimer of the same import as rectigradation. (Eimer-Cunningham, "Organic Evolution as the Result of Acquired Characters," 1890.)

VIII. *The principle of experimental adaptation.* This principle is fundamental; the "trial and error" or experimental impulse as observed in the freely moving Protozoa prevails throughout the animal kingdom and is one of the chief ontogenetic phenomena. Thus many of the higher mammals, especially the equines and the proboscideans, guide their own evolution through initiative and resourcefulness just as man is able to guide his own evolution in adaptation to new conditions of environment and biota. This principle in part accounts for the extraordinary diversity of the mammalian kingdom, which since the close of the Cretaceous has radiated from small rat-like forms into the marvellous diversity of the existing mammalian life, while the Crocodilia and Testudinata remain as they were at the close of the Age of Reptiles.

IX. *The principle of adaptive radiation*, continental, local, oceanic. While all sessile organisms like plants and sessile invertebrates develop superb bio-mechanisms simply in direct reaction to stresses and strains, and while static organisms like the Crocodilia and Testudinata remain in the condition of arrested development through conservation of habit, the freely mobile organisms like the Lacertilia and Ophidia among reptiles, the birds, and all divisions of the mammals enter new ontogenetic and phylogenetic phases through the principle of adaptive radiation (Osborn), which is an elaboration of Lamarck's *ébranchement* and Darwin's "divergence". Repeatedly in all four classes of vertebrates we observe the cycle of terrestrial, fossorial, aquatic, often ending in marine adaptation of the body and limbs. Also terrestrial, arboreal, glissant, and volant forms arise. Meanwhile insectivorous diet may branch into carnivorous or omnivorous on one hand, or into herbivorous or frugivorous, leaf-eating, browsing, grazing adaptations of the general mechanism on the other. Under this principle as developed by Osborn fall the bio-mechanical processes of convergence, the homoplasy of Lankester, and the alternative habitat discussed and elaborated by Dollo. In every instance where we can observe transition from one habitat or from one feeding to another, the adaptive response of the organism to the new conditions is immediate. The response of heredity to new conditions is very gradual. For example, heredity may conserve "palæotelic" adaptations in a "cœnotelic" exterior. In Gregory's language, "heritage" is long concealed by "habitus," but after the passage of very long periods of time cœnotely replaces palæotely and habitus gives rise to new heritage.

It should be said that, of these nine bio-mechanical principles, five were first observed in zoology and were afterwards confirmed and greatly clarified in palæontology, namely, the principle of function preceding form, the compensation principle of Aristotle and St. Hilaire, the acceleration and retardation principle, the experimental adaptation principle, and the adaptive radiation principle. Four may be observed only in palæontology, namely, the mutation principle of Waagen and the "Mutations richtung" of Neumayr, the rectigradation principle of Osborn, the continuity principle of Waagen, Neumayr, and Osborn.

These nine principles are well-substantiated facts; they are not hypotheses or theories. They include the observed modes by which new mutations, new species, new genera, new families, new orders of vertebrates arise in their bio-mechanical evolution. Every particulate organ of the skull, limbs, and teeth develops and evolves continuously in perfect bio-mechanical response or reaction to fixed or changing life environment and habit. The germ-plasm conditioning this bio-mechanical adaptation also evolves continuously, but lags far behind ontogenic adaptation, whether it be to produce the static mechanism of *Sequoia gigantea* or the mobile mechanism of the sperm whale, *Physeter macrocephalus*, or the no less marvellous mammoth, *Elephas primigenius*. Slowly following in secular time, adaptive reactions to new living environment, to new forms of self-adaptation, there is the onward germinal impulse. The rise of new rectigradations and allometrons in the germ-plasm is not in the nature of vitalism or preformation, but of more or less deferred adaptive reaction to secular experience.

Passing from the boundaries of actual observation, we may point out the bearing of the above nine principles upon some of the current hypotheses and opinions as to the causes of evolution.

It is, for example, frequently stated that environment is the cause of evolution; this is only a quarter truth, as may be seen by consideration of the following eleven observations made in palæontology:

1. *Bio-mechanical evolution* may be as rapid in a fixed physical environment like the ocean as in a changing environment like a continental surface, because bio-mechanical evolution depends as much on living environment (biota), on self-adaptation, on plastic heredity as it does upon physical environment.

2. *As to static heredity*, during the whole changing period of the Age of Mammals, mechanical evolution of two orders of reptiles, the Crocodilia and the Chelonia, was practically arrested, while mechanical evolution of the mammals was extremely rapid. This principle shows that certain animals had a fixed heredity while others had a plastic heredity.

3. *As against Lamarckism* and the Lamarckian hypothesis of the influence of animal intelligence on evolution, mechanical adaptation of the small-brained, cold-blooded reptiles was as great, or greater, during the Age of Reptiles as that of the warm-blooded, large-brained mammals during the Age of Mammals.

4. *As against Lamarckism* which involves the efforts, desires, and movements of animals in mechanical evolution, it may be said that mechanical adaptations in nerveless plants which have no movements or nervous systems are quite as remarkable as are those in the nervous and sensitive and mobile vertebrates. This proves that mechanical adaptation may be quite independent of the nervous system of animals or of the inherited effects of reaction to motion. Nevertheless, as Lamarck believed, all mobile vertebrates, like all human beings, are able to alter the trend of their evolution through the search of new food (biota), through meeting new competitors (biota), through entering new environment by geologic change or by migration (environment), through self-adaptation by new habits (ontogeny).

5. *As against Lamarckism*, in the horse family it is observed that mechanical evolution of the limbs and feet, which are rapidly improved and adapted by habit (ontogeny), is less rapid and less remarkable than the mechanical evolution of the teeth, organs which are entirely preformed by heredity and are destroyed by use and habit in ontogeny. The same is true of the marvellous mechanical evolution of the grinding teeth of the Proboscidea.

6. *As against Darwin's principle* of bio-mechanical evolution through selection and the survival of favourable variations, we observe that the mechanical evolution of the most rapidly breeding animals, such as the rodents, was much less extreme during the Pleistocene time than the mechanical evolution of the slowest breeding animals, the elephants. During the 500,000 years of the Pleistocene period there was an intensely rapid evolution of the dental mechanism of the slow-breeding elephant and little or no evolution in the dental evolution of the fast-breeding rodents.

7. *As against both Lamarck and Darwin*, the principle of rectigradation (Osborn) shows that new

mechanical adaptation organs arise out of the germ-plasm without the antecedent action of self-adaptation. (*a*) While in all parts of the skeleton the principle of mechanical self-adaptation prevails and new proportions, new characters, new adaptations, new functions, new modes of locomotion may be created in the lifetime of a single individual, all that is transmissible in heredity is the germinal variation to plasticity or adaptability in the desired direction, which may be accumulated through coincident selection as applied by Osborn, Baldwin, and Morgan. (*b*) Even more perfect mechanical adaptations arise in the grinding teeth which are not perfected during lifetime.

8. *As against mutational or saltatory hypotheses of evolution* hitherto held by Bateson and his school, the principle of bio-mechanical continuity is so firmly established that we may attribute all discontinuity in bio-mechanical evolution to abnormal, unnatural, pathogenic causes or, through recent discovery, to endocrinal disturbance. Whatever may be true in bio-chemical evolution, in colour, in immunity, in metabolism and phenomena of that order, we may be certain that the bio-mechanical evolution of the skeleton and teeth as observed in palæontology assumes and follows its firm and undeviating order.

9. *Bio-mechanical evolution as observed in full palæontological series*, whether vertebrate or invertebrate, gives the death-blow to the chance hypothesis of Democritus and Empedocles raised into a scientific system in the subsidiary fortuitous selection hypothesis of Darwin. Nature is observed to take no chances, either in the transformation of existing mechanical organs or in the origin of new mechanical characters and inventions. New parts of the organic machine arise in rudimentary condition but perfect order out of the germ-plasm when the demand for them arises, they do not arise automatically without an antecedent bio-mechanical stimulus. They play their continuously adaptive service; when no longer useful they subside and sink back into the germ-plasm, where the power of reproduction is ultimately lost.

Every single one of hundreds of bio-mechanical characters of which the evolution has been observed follows the nine principles enunciated above

10. *The loss of bio-mechanical organs* in the vertebrates is never sudden, as if due to the presence and absence principle of Mendelism. Organs evolved through a long process of continuity show remarkable heritable stability, like longheadedness in man or in the hoofed mammals when crossed with broadheaded types. In the horse-ass hybrid, for example, most of the bio-mechanical skeletal characters transmitted are those of the horse, all of which have evolved over a very long period of time—hundreds of thousands of years. Certain of the bio-mechanical characters and most of the psychic characters are those of the ass Thus a continuity in bio-mechanical evolution may give rise to Mendelian discontinuity in hybridising, exactly as it does in the matter of bio-chemical evolution.

11. *Every race will more or less rapidly lose its typical form* in any one of four ways consistent with the tetraplastic and tetrakinetic principle of Osborn. (*a*) by alteration of its internal energies of heredity (phylogeny); (*b*) by alteration of the external energies of environment; (*c*) by alteration of the external energies of the biota of plant and animal environment, (*d*) by alteration of the internal energies of habit or ontogeny. Any one of these four energetic changes will immediately precipitate a new action of selection, and as a secular process will alter the germ-plasm

It appears from these eleven observations that palæontology is a two-edged sword which is equally ruthless in the Darwin-Weismann and the Lamarckian fields of speculation.

In conclusion, what really happens in the natural origin of species in bio-mechanical characters is this: *Whenever all the four energetic conditions of heredity, of environment, of biota, of habit or ontogeny, and the non-energetic condition of the struggle for existence (selection) are the same, there will arise similar ascending mutations, species, genera, families* New similar or parallel species of hoofed animals actually arise at approximately, if not at precisely, the same rate, whether we observe them in France, Mongolia, or the Rocky Mountain region

My rejoinder to Bateson's statement[6] that "the origin and nature of *species* remains utterly mysterious" is that thirty-six years of intensive palæontologic exploration and research have so clearly and repeatedly revealed how new bio-mechanical species arise that we can safely predict not only what the species is, but also where it is most likely to be found and in what stage of evolution it will be found Such prediction has recently been fulfilled in a most brilliant manner in our discoveries of the Titanotheres in central Mongolia. Whatever may prove true as regards species founded on bio-physical or bio-chemical characters, the research is nearly closed on the modes of origin of bio-mechanical species, because we have little more to learn.

The *causes* of these origins is quite another matter. Some day we may be able to work out the separate contribution of each of the four energetic factors, heredity, environment, ontogeny, biota to germinal evolution. We palæontologists observe exactly how the process of germinal evolution of bio-mechanical characters goes on, adaptive in every stage, just as the embryologists observe how the process of adaptive development goes on whereby the invisible germ turns gradually into the adult and perfected skeleton and teeth There is no accident in either mode of transformation, evolutionary or developmental, nor is there anything that we can comprehend. On the whole, the order of evolution imitates the order of development; both processes, to our mind, are equally inexplicable, and will probably remain so.

[6] William Bateson's observations on discontinuity in the origin of species first appeared in his "Materials for the Study of Variation," 1894. More recent are his British Association address in Australia and his address at the Toronto meeting of the American Association quoted from above.

Accuracy of Weighing in the Eighth Century.

TWO recent papers in the *Numismatic Chronicle*[1] contain interesting information on the remarkable accuracy of ancient weighing. Dr. G. F. Hill mentions that in a hoard of 20 gold staters of Lysimachus (*c.* 355–281 B.C.), in mint state, the extreme weights were 8·62 and 8·42 grams, *i.e.* the maximum variation was 2·3 per cent. Eleven of the coins, however, had weights with a much smaller range, namely, 8·57 to 8·52 grams, a variation of only 0·58 per cent. Dr. Hill considers this degree of accuracy to be no greater than might be obtained by cutting a bar of uniform thickness into equal lengths with an ordinary measure. The smallest weight about which the Greeks cared seems to have been not less than 0·05 gram.

Much greater accuracy is shown in certain Arabian glass coin-weights of the eighth century which are described by Sir Flinders Petrie. The average error of dinar and dirham weights of this century is 0·004 gram; in the early weights the accuracy is

[1] G. F. Hill, "The Frequency Table," Fifth Series, vol. 4, p. 76, 1924; W. M. F. Petrie, "Glass Weights," Fourth Series, vol. 18, p. 111, 1918.

even finer. Thus in 780 "the astonishing result of three weights is 32·662, 32·665, and 32 667 grains," or all within a third of a milligram As Sir Flinders says, "to reach such accuracy it was needful to use the finest chemical balance, with closed case, double weigh the glass weights against each other, and read a long series of swings of the balance How such accuracy was reached in the manufacture is incomprehensible Nothing known of any other age at all approaches the fine weighing of the eighth century."

That the Arabs made an intensive study of the balance from both the theoretical and the practical sides, is well known. There is, indeed, a wide literature on this subject, which was considered to be a distinct branch of science. The celebrated mathematician Thābit ibn Qurra (836–901) wrote on the Roman balance or *qarasṭūn* (χαριστίων) a treatise ("Kitāb fi'l-Qarastūn") which is still extant (MSS. Berlin, 6023; India Office, 767, No 7). Other authors who dealt with the theory or practice of weighing are Al-Farabi, Avicenna, Qusta ibn Luqa, and Ibn al-Haitham Most important of all, however, is the treatise written by Al-Khazini in 1121 for the Sultan Sinjar. "This is not confined to the description of various balances but includes also geometrical and physical considerations on everything connected with weight Notably, it gives theorems on centres of gravity according to Ibn al-Haitham and Al-Kuhi; it mentions an instrument for measuring liquids, after Pappus, it touches on philosophical problems and, with Thābit, seeks for the 'different causes of heaviness'"[1] Al-Khazini's book, which is entitled "The Book of the Balance of Wisdom," contains an excellent description of the hydrostatic balance and gives tables of specific gravities which differ in general very little from the values accepted at the present day—that of lead, for example, is given as 11·33, which compares very well with our value of 11 35.

In spite of this attention to the science of the balance, it appears that accuracy in weighing deteriorated after the eighth century. Perhaps it is a mere coincidence, but it is worth noticing that the eighth century was the time in which Arabic chemistry reached its zenith. The balance continued to play an important part in chemical laboratories, however, and we find that Al-Jildaki, who died about 1360, makes the remarkable statement that "substances do not react except by definite weights."

An excellent picture of a mediæval chemical balance, in a closed glass case, is given in the British Museum MS. of Thomas Norton's "Ordinall of Alkimy."

E. J. H.

[1] Baron Carra de Vaux, "Les Penseurs de l'Islam," vol 2, p 181.

University and Educational Intelligence.

ABERDEEN.—Prof R. W. Reid has intimated his resignation from the chair of anatomy, which he has held since 1889

BRISTOL.—On Tuesday, June 9, their Majesties the King and Queen visited Bristol, where they opened the new buildings of the University, as recorded in our issue of June 13, p. 913. Before proceeding to the University, the King received an address from the civic authorities, and in his reply, referring to the great generosity to the University shown by the Wills family, said that it "is a convincing proof that the race of pious founders and benefactors did not become extinct with the passing of the Middle Ages." At the University, the Chancellor, Lord Haldane, presented an address in which he pointed out clearly the significance of the university in modern life. "It is our happy lot and duty," he said, "to cultivate and encourage learning both by imparting knowledge to those who seek it, and not less by providing facilities for its development through maturer study and research. . . . We are conscious, too, that it is incumbent upon us to bring science to the aid of industry." In his reply, the King enlarged upon this theme. The duties of the universities are: "To hold in trust for the common use the treasures of past thought, to provide for the creative minds of the present a congenial and stimulating home, to give to all the opportunity of a liberal education in the arts and sciences. . . Their responsibilities are heavy, as their opportunities are great; and they can only rise to the full measure of their task if they be strong in public sympathy and support."

Honorary degrees were conferred on June 10 upon a few distinguished representatives of the Church, arts, and science who are natives of Bristol, or have been associated with the city or the neighbouring districts through education or public service Among these were Lord Bledisloe, Sir Richard Gregory, and Sir J. Herbert Parsons, each of whom received the degree of D.Sc.

CAMBRIDGE.—Dr. A. B Appleton, Downing College; Mr. D G. Reid, Trinity College; Mr. A. Hopkinson, Emmanuel College, and Mr. V. C. Pennell, Pembroke College, have been reappointed as demonstrators of anatomy.

The Council of the Royal Agricultural Society has notified the University that it is prepared to grant the interest on the money given to the Society in 1896 by the late Sir Walter Gilbey to the University of Cambridge to assist the University to maintain the Gilbey lectureship in the history and economics of agriculture.

LEEDS.—Dr. W H. Maxwell Telling, who has occupied the chair of therapeutics for the past two years, has been elected University professor of medicine and head of the Department of Medicine, as from October 1, on the retirement of Dr. T. Wardrop Griffith.

LONDON.—The Johnston-Lavis Geophysical Collection, which was bequeathed to the University of London by the late Dr. Henry James Johnston-Lavis, will be formally opened at University College on Thursday, June 25, at 4 P.M. After the opening ceremony has been performed by Sir Henry A. Miers, Vice-Chancellor of the University of Manchester, in the main college buildings, visitors will have an opportunity of inspecting the Collection in its temporary quarters at 134 Gower Street. Those who would care to attend are requested to communicate with the Secretary of the College.

THE Liddle triennial prize, value 120*l.*, of the London Hospital Medical College is being offered for an essay on "The etiology and treatment of primary high blood pressure." Competing papers should be sent by at latest January 30 next to the dean of the college, Turner Street, E.1.

APPLICATIONS are invited for the Gull studentship in pathology and allied subjects, including bacteriology, at Guy's Hospital Medical School. The studentship is open to candidates who have studied at the medical school of Guy's Hospital. It is of the annual value of 250*l.* and is tenable for three years. The latest date for the receipt of applications, which should be sent to the Secretary of the Board of Electors, at the School, is July 4.

Early Science at Oxford.

June 22, 1686. The Minutes of the Dublin Society from Apr 26, to May 17th were read: Also a discourse of Mr. Caswels, Shewing how the *Shadow* may *goe back* on an Horizontal plane in any latitude, if the stile point betwixt the Tropics; also on any other plane unlesse the situation thereof keeps the Sun from shining long enough thereon, together with the calculation of the time and quantity of the shadow's regression, according to the various situations, of the stile and plane.

Mr Lloyd haveing observed that many curious Travellers when they visit the Repository, doe occasionally relate some remarques of their own experience, concerning things of *Nature* and *Antiquity*, he thought it might prove of some consequence to provide a Book that should lye in the Repository, wherein he might breifly set down, the contents of such relations, desireing each Gentleman to subscribe to what he communicated.

'Twas ordered that such relations should be transcribed into the Minute Book in ye method indicated by two examples written out in full by Mr Lloyd.

June 23, 1685. Dr. Plot presented severall Birds, as ye Puffin, Razor Bill, and ye Eligug, together with ye Egges of each Species; the Egges were observed to be large, but especially those of ye Puffin

He communicated an account of incombustible cloth, drawn up by way of letter to Mr Bayly, Fellow of ye Royal Society, and Mr Wait, both Merchants of London; this discourse was read

June 24, 1684. A Letter from Mr. Aston, dated June ye 21st 1684 was read, which mentioning an experiment lately made before ye Royall Society, for finding ye quantity of air, contained in Iron, it was ordered, that Mr. Aston be desired to communicate ye manner, and method, of that Experiment In this letter were contain'd ye Minutes of ye Dublin Society, from Aprill ye 28th to June ye 2d., which mentioning that a Dog, haveing about 2 inches in depth, and 3 or 4, in bredth, cut off from one of ye lobes of his lungs, recovered *it without any injury to him*, Mr. Musgrave assured ye Society, that ye same Experiment was tried by Dr. Lower, here in Oxon, many years since, with ye same success, as he heard from Mr. Fry, formerly a Chyrurgion in this Town, who assisted ye Doctor in that Experiment.

These Minutes giving also an account that one of ye externall jugulars of a Dog, was tied without injuring ye Dog. Mr. Musgrave read a paper, acquainting ye Society with what he did in this kind ye last March: the paper is as follows: Sometime in March last, I tied ye 2 externall jugulars of a dog, and cut off ye veins, on this side of ye Ligatures, towards ye heart: The same experiment was tried many years since, by ye famous Dr Lower (see his book *de corde*, pag: 112, ed. Amstel: 1671)

These were ye strange effects of ye Doctor's experiment, and my success, in repeating it, was also somewhat surprising, but on a different account; for I could never find, that ye dog, on which I tryed this experiment, was any way concerned, otherwise than at ye wound, I found no alteration in him at all, that I could impute to ye stoppage of ye circulation, in ye veins before mentioned &c.

About 3 weeks after this experiment, ye wounds being now heald, I tried another Experiment on ye same dog, under which he died: I examin'd him as to ye jugulars, which I found almost dried up:

This experiment was tried in ye presence of Mr. Paige, and some others, of New College.

Ordered, ye Eclipse of ye Sun on 2 July next, to be strictly observed.

Societies and Academies.

LONDON

Royal Society, June 11.—R **Magnus**: Animal posture (Croonian Lecture). Postural centres in brain-stem compound the body musculature to combined action. Postural stimuli arise from many different sense organs. Change in position of one part of the body is followed by postural (usually harmonious) changes in other parts Postures are adapted to environment by combined action of distance receptors and attitudinal reflexes The righting function, absent in decerebrate, is present in midbrain animals Righting reflexes evoked from labyrintha, exteroceptors, and proprioceptors, bring head and body into normal position. Optical righting reflexes are present in higher mammals only Paralysis of one righting apparatus is usually compensated by other righting reflexes Centres for righting are arranged subcortically. The resting position of the eyes changes with different positions of head, and is controlled by postural reflexes In animals with lateral eyes (rabbits) the visual world remains fixed in spite of head movements This is accomplished by the combined action of otolithic and neck reflexes Motor reflexes from the semicircular canals initiate these static reactions of the eyes Centres for all these reflexes are arranged in three groups The red nucleus is the centre for two of the righting reflexes Labyrinthine reactions have greater importance in lower mammals Postural function of other parts of brain is largely unknown.

Royal Anthropological Institute, May 5.—V **Gordon-Childe**: The lake dwellings in Europe in the light of the new excavations Prior to 1920 our conception of the development of civilisation among the inhabitants of the pile villages of the Alps was perforce based on *a priori* typological analysis of the heterogeneous material dredged up haphazard These conceptions were largely erroneous On Lake Neuchâtel, Dr. Vouga has found at several sites no less than four superimposed settlements The oldest villagers used jadeite more freely and made much finer pottery than their successors. They possessed all the domestic animals and depended less on food-gathering than the later settlers, on the other hand, they may have been cannibals In Wurtemburg the studies of Runerth of Tübingen have rendered possible the reconstruction of several types of neolithic houses and revealed pottery some of which is related to both the earliest fabrics of Lake Neuchâtel and those in use in the Danube Valley in the second neolithic period there. Beside the well-known Bronze Age village on Laibach Moor, an earlier settlement has been identified which, despite a "neolithic" inventory, probably belonged to the dawn of the age of metal as whetstones were found. On Lake Alvastra in Sweden a pile dwelling of the stone age was excavated in 1911. Its occupants had practised agriculture and possessed artefacts similar to those of the megalith builders on the coasts, but their pottery and celts were of types proper to the food-gathering population of the "dwelling-places." The "neolithic" elements from the Swedish and Swiss lake dwellings are fundamentally different. It is therefore impossible to attribute both the pile-dwelling habit and the neolithic civilisation to the "brachycephalic invaders" assumed by classical theory. Incidentally the more easterly and southerly lake-dwellings at Laibach and in Bosnia are later than the western and northern. On the other hand, a race of hunters and fishers had inhabited rafts in the early neolithic (dolmen) period in Scandinavia and even earlier in the mesolithic period in Denmark and

Yorkshire. At the same time much of the industry revealed in lake dwellings south of the Alps and Scandinavia may be derived from the mesolithic—horn harpoons and sleeves, wooden boomerangs, phalange whistles, etc It is therefore suggested that the lake dwellers are descendants of the mesolithic food-gatherers, that the lake dwellings are improvements on the mesolithic raft—an intermediate phase being illustrated by the platform structures of Denmark and West Switzerland—but that the neolithic arts were borrowed from more advanced peoples, the Danubians in the Alps, the megalith builders in Scandinavia.

Geological Society, May 6.—E. B. **Bailey**: The Tertiary igneous geology of the Island of Mull In Judd's region of central pneumatolysis (propylitisation), within an area measuring 15 miles in diameter, it is impossible to find a lava that has retained its olivine undecomposed. Referring to Judd's conception of central subsidence, it now appears, from the disposition of lava-types and other considerations, that central subsidence culminates in two adjacent calderas The occurrence of many pillow-lavas within one of these calderas—at the centre of a manifestly terrestrial volcano—points to the frequent presence of a crater-lake The crater-hollow must have been renewed by intermittent subsidence Ring-dykes are numerous. There is conspicuous folding attributable to the lateral expansion of an early ring-dyke Similar folding does not recur in connexion with later ring-dykes. Several ring-dykes in Mull show gravitational differentiation, which took place during crystallisation.

Physical Society, May 8.—E **Hughes**: A magnetic bridge for testing straight specimens and an analysis of the hysteresis loop of cobalt-chrome steel. The author employs a permeameter resembling that of Iliovici, in which the currents in two coils providing the M.M.F. of a magnetic circuit containing the specimen are adjusted until no magnetic potential difference exists between a selected pair of fixed points on the specimen. In the present apparatus the required absence of magnetic potential difference is tested by bringing up a yoke until its ends abut upon the two points in question: the approach of the yoke should excite no current in a search coil wound on the specimen and connected in a low-resistance galvanometer circuit Resistance is then added to the galvanometer, and the deflexion caused by a reversal of the two magnetising currents enables the permeability to be calculated. To form a permanent magnet the energy of which per c.c. is within 5 per cent of the maximum obtainable, a magnetising force of upwards of 1000 C.G.S. units must be applied.—M. C. **Johnson**. The experimental control of electrically broadened spectral lines. Concentration of ions is the obvious controlling factor if the Stark hypothesis be adopted; recombination of ions on this hypothesis may explain the capacity and inductance curves obtained in these experiments, between 0·3 and 1·0 A.U. This view is further tested by controlling the broadening without altering the current in the tube or the period of the discharge. The several effects involved are accounted for on the theory that line width depends on the number of charges which surround an emitting particle.—K. **Rangadhama Rao**: The spectra of the metals of the aluminium sub-group. Continuing the previous work on absorption of light by thallium vapour, the author has now studied the absorption of thallium vapour from λ2400 to λ2000, and that of indium from λ6000 to λ2000. The absorption tube was of steel, and provided with quartz windows at the ends, and absorption was studied with a quartz spectrograph. The absorption spectra indicate marked similarities. None of the lines of the principal series appeared in absorption, even at the highest temperatures used. One remarkable feature is the very marked absorption of the members of $1\pi_3$—ms'.

CAMBRIDGE.

Philosophical Society, May 4.—R. H. **Fowler**: A theoretical study of the stopping power of hydrogen atoms for α-particles. The problem of the stopping power of light atoms for α-particles has been reopened by Bohr, in a way which will allow of the retention of a purely mechanical calculation of the effect on the α-particle in spite of the quantum restrictions on the reactions on the atoms. This mechanical calculation of the energy lost by the α-particle is carried out, taking into account the actual orbits of the electrons, instead of assuming elastically bound electrons. Circular orbits in a Coulomb field are dealt with by the method of perturbations. These must be carried to the second order for the energy, as the mean value of the first order transfer of energy is zero. The result is the same in form as Bohr's former result, but gives a slightly greater numerical value to the stopping power, which is about 10 per cent. larger as here calculated than the measured stopping powers for He and H_2.—K. G **Emeléus**: The action of the electrical counter. With the point positive an effect can be expected proportional to the initial ionisation due to the particle being recorded, whilst when it is negative a much larger discharge should be obtained which is almost independent of the initial ionisation. Extinction of the discharge at atmospheric pressure is brought about by a local increase of pressure near the tip of the point, probably accompanied by an electric wind along the side of the needle.—F. H. **Constable**. An apparatus for the investigation of the effect of poisonous substances, and mixed vapours on catalytic activity. Vapour mixtures of known composition can be supplied at a constant rate to the catalyst, which is maintained at a definite temperature. The general theory of "Centres of Activity" has been applied to selective poisoning. The decay of the reaction velocity occurs according to a logarithmic law, and the temperature coefficient is unchanged by moderate poisoning in cases in which a small fraction of the surface is catalytically active. Neither poisoning nor sintering alters the temperature coefficient of a chemical reaction, and the activity of a poisoned catalyst falls in accord with a simple logarithmic law.—R. A. **Fisher**: Theory of statistical estimation.—W. **Burnside**: (1) On the idea of frequency. (2) On the representation of the modular group of order $\frac{1}{2}p(p^3-1)$ as a group of linear substitutions on $\frac{1}{2}(p-1)$ symbols, when p is a prime of the form $4n+3$.—J. P. **Gabbatt**: On pedal quadrics in non-euclidean hyperspace.—F. P. **White**: An extension of Wallace's, Miquel's, and Clifford's theorems on circles.—H. F. **Baker**: (1) The stability of rotating masses of liquid. (2) Note on a formula for Lamé functions.—M. J. M. **Hill**: (1) On the substitution of Wallis's postulate of similarity for Euclid's postulate of parallels. (2) On the hypothesis of the obtuse angle.—J. D. **Cockcroft**: The temperature distribution in a transformer in which heat is generated at a uniform rate. The continued increase in the size of transformers has made a more exact knowledge of the temperature distribution in the laminated cores necessary. The temperature distribution in an infinite rectangular laminated core is found and the solution applied to an oil-cooled transformer core.—C. G. F. **James**: Some formulæ for scrolls and line systems in higher space.

DUBLIN.

Royal Dublin Society, May 26.—Report of the Irish Radium Committee for the year 1924. The report shows that 12,885 millicuries of emanation were issued for therapeutic purposes during the year. A temporary laboratory has been fitted up at Ballsbridge for carrying on the work of the Radium Institute. Reports from some of the largest medical users of emanation in Ireland are included. These contain numerous records of successful results obtained with radium treatment.—F. E. **Hackett**: The Zeleny electroscope and its uses as a lecture demonstration instrument.

PARIS

Academy of Sciences, May 18.—F. E. **Fournier**: General properties of the simple satellite wave produced by the translation of hulls of forms favourable to high speeds.—Maurice **Hamy**: Cutting optical surfaces with elliptical or hyperbolic sections.—H. **Deslandres**. Complementary researches on the structure and distribution of band spectra. New measurements of absorption bands in the infra-red of oxygen, carbon monoxide, hydrocyanic acid, ammonia, water vapour and methane. For these six gases the absorption bands may be represented by the formula $K = q^{-\frac{1062 \cdot 5}{r.s}}$, where q is an integer, r is an integer, and s a third integer equal to the number of atoms in the molecule.—Marin **Molliard**: The action of high temperatures, compatible with life, on the development of cells: Studies in the mode of development of *Sterigmatocystis nigra* at temperatures ranging between 36° C. and 44° C.—L. **Lindet**: The coagulation of casein in the presence of calcium salts in acid solution.—C. **Sauvageau**. The culture of the alga *Strepsithalia Liagorae*.—V. **Romanowsky**: The generalisation of an inequality of A. Markoff.—J. **Le Roux**: The variation of mass.—Raymond **Chevallier**: Ferromagnetic ferric oxide. Starting with a commercial finely powdered black oxide of iron, this is oxidised by air at a temperature of 350° C. It then has the composition of ordinary ferric oxide but is of a yellowish colour and is strongly magnetic. This ferromagnetism is lost on raising the temperature to about 700° C.—Marcel **Peschard**: The magnetisation of the ferro-nickels: thermomagnetic properties.—S. **Pina de Rubies**: New lanthanum lines in the arc spectrum at normal pressure between 3100 I.Å. and 2200 I.Å.—Jean **Lecomte**: The infra-red absorption spectrum of aldehydes and ketones. The absorption spectra of the fatty aldehydes and their isomeric ketones are not identical, and the characteristic band of the carbonyl group is not the same in the fatty and aromatic series. For a thickness of a small fraction of a millimetre, aldehydes and ketones give absorption spectra showing well-defined strong bands capable of being utilised for analytical purposes.—R. **de Mallemann**: The electrical double refraction of limonene. Kerr's constant for limonene is intermediate between that of benzene and that of toluene; it is nearly four times that of pinene, a difference attributed by the author to the presence in the molecule of a double bond external to the ring.—L. **de Broglie** and Jean Jacques **Trillat**: The physical interpretation of the X-ray spectra of the fatty acids.—Mlle. Irène **Curie** and Nobuo **Yamada**: The particles of long range emitted by polonium. The lack of homogeneity in the metallic screens employed in previous work was found to give rise to difficulties, and these screens have been replaced by a layer of compressed gas (dried air, oxygen, or carbon dioxide). It was proved that the arresting power of these gases was proportional to the pressure. In spite of the precautions taken in the preparation and preservation of the specimens, there always remained a small number of particles with a long range, and this number is nearly proportional to the quantity of polonium, but does not depend on the nature of the metal on which the polonium is deposited. These particles do not form a homogeneous group.—Georges **Fournier**: The absorption of β rays by matter.—Pierre **Chevenard** and Albert **Portevin**: Results obtained by the dilatometric study of cast irons. The dilatometric study of cast iron enables the complex transformations produced during heating or cooling to be followed, and appears to possess advantages over the thermal method for phenomena occurring in the solid state.—Xavier **Waché** and Georges **Chaudron**: The influence of thermal and mechanical treatment on the velocity of solution in hydrochloric acid.—E. **Demoussy**: The displacement of acids by diffusion. The consideration of the relative mobilities of the ions of a mixture of salt plus acid, together with a knowledge of the degree of ionisation of the acid, suffices to predict the direction of the partition of the diffusion products.—H. **Pelabon**. The direct formation of the mercury oxybromides.—Mlle. S. **Leduc**. The action of *p*-anisyl magnesium bromide and *p*-tolyl magnesium bromide on camphor.—L. **Bert**: A general synthetical method for the preparation of ω-chlorallyl cyclic derivatives, and through these, acetylenic hydrocarbons, alcohols, and aldehydes. The reaction

$$RMgX + CH_2Cl - CH = CHCl = RCH_2 - CH = CHCl + MgXCl$$

has been realised experimentally when R is C_6H_5. The reaction has been proved to be general for other aryl groups.—Georges **Brus**: The action of chlorine on α-pinene. Starting with pure pinene, free from nopinene, the author has obtained bornyl chloride, liquid dichlorides, a crystalline dichloride differing from products previously obtained in this reaction, together with small quantities of higher chlorine derivatives.—R. **Lantz**: The arylaminonaphthoquinones. The action of aromatic amines.—L. **Cayeux**: The submarine origin of the silex nodules and beds of chalk of the Paris basin.—Frédéric **Hermann**: The bundle of reversed folds of Valsavarenche and the prolongations of the Bagnes fan in the Franco-Italian Alps.—A. **Demolon**. The chemical constitution of brick earth.—Aug. **Chevalier**: The Leguminoseæ (Tephrosia) cultivated in tropical countries for capturing fish, their use and geographical distribution.—St. **Jonesco**: The action of mineral and organic acids combined with that of metallic sodium on the reddening of some flavones.—P. **Lasareff**: The sensation of the intensity of sounds according to the ionic theory of stimulation.—R. **Legendre**: The principle of a method for estimating the variations of dissolved carbonic acid.—A. H. **Roffo**: Cholesterol and hæmolysis.—W. **Kopaczewski**: Electrocapillary analysis of colloidal colouring matters.—Ch. **Porcher**: The various complexes, caseinate of lime + phosphate of lime, and their mode of behaviour towards rennet.—G. **Guittoneau**: The rôle of rennet and its mode of action in the manufacture of Gruyère and Emmenthal cheeses.—**Lemoigne**: The origin of the β-oxybutyric acid obtained by the action of micro-organisms. The non-autolysed *M. bacillus* contains an amorphous product, which can be isolated by chloroform and after saponification gives α-crotonic acid. The latter product may be considered as the mother substance of the β-oxybutyric acid.—Clément **Simon**, Ch. **Flandin**, **Seguin** and **Lecoq**: The action, *in vitro*, of pancreatic extracts on the Nagana trypanosome and *Spirochæta Gallinarum*.—**Robineau** and G. **Contremoulins**: The reactions on the human organism of prothetic or synthetic bone sterilised by boiling alcohol.

Official Publications Received.

Department of the Interior: United States Geological Survey. Water-Supply Paper 541: Surface Water Supply of the United States, 1922 Part 1: North Atlantic Slope Drainage Basins Pp. vi+258+2 plates. (Washington: Government Printing Office.) 25 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia Vol. 76, 1924. Pp iii+444+21 plates. (Philadelphia) 6 25 dollars.

Smithsonian Miscellaneous Collections Vol 77, No 2 Explorations and Field-Work of the Smithsonian Institution in 1924 (Publication 2794.) Pp. iii+186 (Washington. Smithsonian Institution)

Department of Commerce U S. Coast and Geodetic Survey. Serial No. 293. Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Ariz, 1921 and 1922 By Daniel L Hazard Pp. 99+5 plates. Serial No. 292: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Vieques, P R, in 1921 and 1922. By Daniel L Hazard. Pp. 98+4 plates. (Washington Government Printing Office.) 15 cents each

Experimental Vegetation: the Relation of Climaxes to Climates By Frederic E Clements and John E Weaver (Publication No 355) Pp vii+172+15 plates. (Washington: Carnegie Institution)

The Phytometer Method in Ecology the Plant and Community as Instruments. By Frederic E Clements and Glenn W Goldsmith (Publication No. 356) Pp. vi+106+11 plates (Washington Carnegie Institution)

Papers from the Department of Marine Biology of the Carnegie Institution of Washington Vol 19. A Memorial to Alfred Goldsborough Mayor. Some Posthumous Papers of A G Mayor, relating to his Work at Tutulla Island and adjacent Regions together with Reports of R A Daly, R T Chamberlin and C B. Lipman on their Work in the same Connection (Publication No 340) Pp viii+217+56 plates (Washington Carnegie Institution)

Cenozoic Gravigrade Edentates of Western North America, with Special Reference to the Pleistocene Megalonychinae and Mylodontidae of Rancho La Brea By Chester Stock. (Publication No 331.) Pp. xiii+206+48 plates (Washington Carnegie Institution.)

Contributions to Embryology Vol 16, Nos 78-84. (Publication No. 361) Pp 276+32 plates (Washington Carnegie Institution)

City of Norwich. The Report of the Castle Museum Committee to the Council, 1924 Pp 25. (Norwich)

Transactions of the Astronomical Observatory of Yale University Vol 3, Part 3 Theory of the Trojan Group of Asteroids Conclusion of Chapter I, and Chapters II to VI Development of the Theory and Applications By Prof Ernest W. Brown Pp, 81-133 (New Haven)

United States Department of Agriculture. Department Bulletin No 1324: The Oviposition Response of Insects By Charles H Richardson Pp 18 (Washington Government Printing Office) 5 cents

Forest Bulletin No 60 Note on *Ainee, Artocarpus hirsuta*, Lamk By C Claude Wilson Pp ii+7+4 plates (Calcutta Government of India Central Publication Branch) 7 annas, 9d

Union of South Africa Department of Mines and Industries: Geological Survey Memoir No 19 The Coal Resources of Union of South Africa Vol 2: The Inland Coalfields of Natal By W J Wybergh Pp 180+6 plates. (Pretoria: Government Printing and Stationery Office) 10s

The Indian Forest Records. Silviculture Series, Vol 11, Part 2 Contributions towards a Knowledge of Twisted Fibre in Trees By H G Champion Pp v+70+18 plates 2 8 rupees, 4s 6d Entomology Series, Vol 11, Part 4 On some Indian Brenthidæ (Coleoptera) Part I Neue Brenthiden aus Britisch Indien und den anliegenden Gebieten, von Richard Kleine, Part 2: Notes on the Biology of the Brenthidæ, by Dr C. F. C Beeson, Part 3 Descriptions of the Larvæ of *Cerolates tristratus* and *C. serrulcatus*, and of the Pupa of *Cyphagogus corporaali*, by J C M Gardner Pp ii+48+15+6+4 plates 1 5 rupees, 2s 9d Chemistry Series, Vol 11, Part 6 The Constituents of some Indian Essential Oils Part 17. By Madyar Gopal Rau and John Lionel Simonsen Pp 8. 2 annas, 3d. (Calcutta: Government of India Central Publication Branch)

The Royal Society for the Protection of Birds Thirty-fourth Annual Report, January 1st to December 31st, 1924, with Proceedings of Annual Meeting, 1925 Pp. 94. (London, 82 Victoria Street, S W 1.) 1s

Proceedings of the South London Entomological and Natural History Society, 1924-25. Pp. xix+142+8 plates. (London: Hibernia Chambers, London Bridge, S E 1.) 12s 6d.

Field Museum of Natural History Zoological Series, Vol 12, No. 8: Two new Birds from Peru. Reports on Results of the Captain Marshall Field Expeditions. By John T Zimmer. (Publication 238) Pp 101-109. (Chicago)

The Journal of the Royal Agricultural Society of England Vol. 85, 1924 Pp 12+447+clviii+x+20. (London: John Murray.) 15s.

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich. Read at the Annual Visitation of the Royal Observatory, 1925, June 6. Pp 21. (Greenwich)

Koninklijk Nederlandsch Meteorologisch Instituut No. 108: Seismische Registrierungen in De Bilt. 10, 1922. Pp. xvi+47. (Utrecht: Kemink en Zoon.) 0.60 f.

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1924. (No. 78.) Pp. 146. (Marlborough) 3s. 6d.

Aeronautical Research Committee. Reports and Memoranda. No. 983 (Ae. 154): Forces and Moments (including those due to Controls) on a Model Fairey "N4" Flying Boat *Atalanta* at various Angles of Yaw. By H B Irving and A S Batson (A.2.a. Stability Calculations and Model Experiments, 87—T 1974.) Pp. 14+12 plates. 1s net. No. 941 (M N. 8): Measurement of Vertical Currents in the Lowest Layers of the Atmosphere during Sea-Breezes. By J. Durward. (A.5. Meteorology, 103—T 1887.) Pp 5+3 plates. 6d. net. No. 952 (Ae. 171): Further Experiments on Honeycomb Radiators. By Dr. R. G. Harris and L. E. Caygill. (A.3 k Miscellaneous 49—T. 1997.) Pp. 20+12 plates. 1s. 3d. net. No. 958 (Ae 177): Lift and Drag of two Aerofoils measured over 360° Range of Incidence By C. N. H. Lock and H. C. H. Townsend. Pp. 5+4 plates 6d. net. (London: H.M. Stationery Office.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 505: Critical Potentials associated with Excitation of Alkali Spark Spectra. By F. L. Mohler. Pp. 165-191. (Washington: Government Printing Office.) 10 cents.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Jaarverslag 1924. Pp. 22 (Weltevreden: Landsdrukkerij.)

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1924. Pp. 11. (Salisbury, Southern Rhodesia.)

British Empire Exhibition, 1925. Official Guide. Edited by G. C Lawrence Pp 128. (London: Fleetway Press, Ltd.) 1s.

Egyptian Government Almanac for the Year 1925. Pp. viii+800. (Cairo, Government Publications Office.) 5 P T.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 105 Jahresversammlung vom 1 bis 4 Oktober 1924 in Luzern. 1 Teil (Actes de la Société Helvétique des Sciences naturelles. 105e session annuelle du 1er au 4 octobre 1924 à Lucerne. 1re partie.) Pp. 252+60. (Aarau: H. R. Sauerländer et Cie.)

Diary of Societies.

SATURDAY, JUNE 20.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Summer Meeting) (at Birmingham University), at 10 45.—Business Meeting.—At 11.30—Dr. Shakespear: Colour (Lecture)

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (in Bio-chemical Laboratory, Cambridge), at 2.30.—Dr. Kay and Dr. Vines: Bone Formation and Experimental Rickets.—At 4 45.—Dr J. F. Gaskell The Relationship of Experimental Pneumonia in Rabbits to the Pneumonias of Childhood

MONDAY, JUNE 22.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Summer Meeting) (at Queen's Hotel, Birmingham), at 9.30 A M. (Also on June 23 and 24.)

ROYAL IRISH ACADEMY, at 4.15

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Prof. J C McLennan, Lord Rayleigh. The Aurora and its Spectrum. Chairman Sir Ernest Rutherford.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8 30.—Presentation of the Royal Gold Medal

TUESDAY, JUNE 23.

ROYAL SOCIETY OF MEDICINE, at 5 30.—General Meeting

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Lt.-Col. J Cunningham. Some Factors in Racial Immunity and Susceptibility to Disease.

WEDNESDAY, JUNE 24

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

GEOLOGICAL SOCIETY OF LONDON, at 5 30.—Prof W. J. Sollas: On a Sagittal Section of the Skull of *Australopithecus africanus*.—D. Parkinson The Faunal Succession in the Carboniferous Limestone and Bowland Shales at Clitheroe and Pendle Hill.—Janet M. M. Dingwall: On Cyathocliisia, a New Genus of Carboniferous Corals.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. I. D. Suttie. An Irrelevant Accretion to the Freudian Theory

THURSDAY, JUNE 25

ROYAL SOCIETY, at 4.30.—D. H Black. β-Ray Spectra of Thorium Disintegration Products.—Miss C. F. Elam: Tensile Tests of Crystals of an Aluminium Zinc Alloy.—Dr. G. Shearer. On the Distribution of Intensity in the X Ray Spectra of Certain Long-Chain Organic Compounds.—C. F. Jenkin: High Frequency Fatigue Tests.—L. W. Bryant and D H. Williams. An Investigation of the Flow of Air around an Aerofoil of Infinite Span. With an Appendix by Prof. G I. Taylor, Note on the Connexion between the Lift of an Aerofoil in a Wind and the Circulation round it.—*To be read in title only*:—Prof. T. H Havelock: Wave Resistance. the Effect of Varying Draught.—Prof C. V. Raman and L. A. Ramdas: The Scattering of Light by Liquid Boundaries and its Relation to Surface Tension, Part III.—W. R. George An Electrical Method for the Study of Impact applied to the Struck String.—F. H. Constable: The Mechanism of Catalytic Decomposition.—S. A Emerson and Dr L. C Martin: The Photometric Matching Field, II.—G S Adair: Partial Osmotic Pressures and Membrane Equilibria.—Miss Mary W. Porter: A Contribution to the Study of the Optical Properties of Mixed Crystals.—H. Gregory and C. T Archer Experimental Determination of the Thermal Conductivities of Gases.—D. B. Deodhar: On the Atmospheric Radio-activity and Indian Weather.—Prof. J. R. Partington and A. B. Howe: The Ratio of the Specific Heats of Hydrogen.—A. Cary and Dr. E. K. Rideal: The Behaviour of Crystals and Lenses of Fats on the Surface of Water. Part I.—G. H. Henderson: The Capture and Loss of Electrons by α-Particles.—Dr. A. S. Parkes: The Effects on Fertility and the Sex-ratio of Sub-Sterility Exposures to X-rays.—R. N. Chrystal: The Genus Dreyfusia (Order Hemiptera, Family Chermesidæ) in Britain and its Relation to the Silver Fir.—T. Moran: The Effect of Low Temperatures on Hens' Eggs.—And other papers.

FRIDAY, JUNE 26.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. A. Russell: The Electrostatic Capacity of Two Spheres when Touching One Another.—Miss S. Marshall and J. O. C. Vick: An Investigation of the Control Conditions under which Newton's Law is valid for the Emission of Heat from Electrically Heated Wires.—I. Jones: Condensation of Nuclei Produced by the Illumination of Air-halogen Mixtures.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section) (at Manchester University).—Dr. H. P. Fairlie and others: Discussion on Chloroform.—S. R. Wilson and Dr. S. McSwiney: Animal Demonstration showing Effects of Adrenalin Injections during Ether and Chloroform Anæsthesia.



SATURDAY, JUNE 27, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2904, VOL. 115]

The North Sea Plaice Investigations.[1]

IT is unnecessary to point out that the plaice occupies a unique position in the eyes of the public and hence of the fishing industry in general. Its southern limit of range is the English Channel, its depth range about seventy fathoms, and its ground sand or sandy mud; its preference is for a temperature of 60°-70° F. It necessarily follows that its chief area is the North Sea, a ground peculiarly important on account of its proximity to centres of population The annual figures of catch for this area showed a falling catch up to 1914 with an increase of fishing, and the problem set to the scientific staff of the Ministry of Agriculture and Fisheries was to ascertain the facts of this fall in conjunction with the food, breeding habits, and rate of growth of the plaice, and with its environment (nature of the bottom, temperature, salinity, etc.), and, if the fall should be established, to suggest remedies. The report before us sums up the whole position, giving the facts and critically considering the possibility of remedies. There is really nothing more to be said, only to consider whether any attempt is to be made to improve the position or not.

Remedies would necessarily entail some degree of interference with the utilisation of the chief plaice grounds of the area, the southern part of the North Sea, in which the English Ministry is particularly interested, in a manner which is comparable to "stock farming," in which the endeavour is to market the maximum amount of meat per unit area, while, by breeding, keeping up the stock to the maximum number that the land will carry. Here there can be at present no artificial growing of fish food, dependence having to be on the natural supply of animal and free-moving life, which, of course, must fluctuate with fluctuating physical conditions. Then, whereas there are only cattle, sheep, and pigs on a farm, here there are a dozen kinds of fish, more or less in feeding competition with each other, the relative values of which in cash and as food must be determined. The annual production of eggs by each fish varies to hundreds of thousands, of which from each fish only a pair must develop to maturity to maintain the stock. Does it pay to increase the number of spawning fish so as to get a still larger number of eggs, or would it be better to kill off a large percentage of fish before they reach maturity? Obviously, as there would be waste of substance in unproductive spawning, this entailing the utilisation of fish food to no farming advantage, a reply must be sought in the question as to what extent plaice may be profitably marketed before maturity.

[1] Ministry of Agriculture and Fisheries Fishery Investigations, Series II., Vol 7, No. 6, 1924. Report on the English Plaice Investigations in the North Sea during the Years 1921–1923 By J O. Borley and D. E. Thursby-Pelham. Pp. 96. (London H.M. Stationery Office, 1925.) 12s. net

Fortunately, to most of these questions science has given answers, as previous reports have shown, but it remained to determine the results of that most gigantic experiment, the closure of the North Sea to fishing vessels during the War, a closure almost complete in the English area. It is shown in the present report that in 1913, 1920, and 1923 there were 24, 33, and 22 thousands of tons of plaice landed from English vessels. These figures point to the conclusion of the experiment, but, lest the fall to pre-War conditions should be deemed to be due to less fishing in 1923, the catch per 100 hours' fishing and per day's absence from port of first-class fishing vessels is computed, the weights of plaice per day caught by a steam trawler in the three years mentioned being 2·1, 3·4, and 1·9 cwt. The whole North Sea is divided up into areas, 1° long. by 0·5° lat., and the figures are worked out for each rectangle in the years 1920 to 1923, and shown in a long series of charts. The analysis goes, however, much further, and the plaice caught are divided into large (above 45 cm.), medium (roughly 34 to 44 cm.), and small (less than 34 cm.), and the numbers of cwt. of each caught per 100 hours' fishing are shown. The breaking up of the area into rectangles does not agree with depths—these are shown by contour lines beneath—nature of the bottom, temperature, currents, etc., but the charts give at a glance an accurate estimate of the adult and semi-adult plaice population of the North Sea, the quality of value for human consumption.

Taking the whole area, a steam trawler in 100 hours' fishing caught in 1920 approximately 7 cwt. large plaice, 8 cwt. medium, and 3 cwt. small, the corresponding figures in 1923 being 2, 4, and 7. We should estimate the food and cash values of the catch in the former year as at least two and a half times greater than in the latter, and the result is an appallingly lessened production of human food and no living wage for the actual plaice fishermen. Foreseeing that any remedy proposed would entail interference with a whole industry, the fullest consideration is given to every figure in a section of the Report entitled "Size Composition of the North Sea Plaice Stock," extraordinary in the knowledge summarised and masterly and concise in treatment. It, in particular, gives the analyses of the results obtained by a number of sea-going fish measurers, who, sailing in commercial vessels, measured upwards of 1,200,000 plaice in the five years from 1919 to 1924; it annihilates any question of differences between "laboratory" and commercial conditions. Lastly, the relation of growth to age in the post-War period is determined, and a full consideration is given to a new post-War method of fishing by the use of seines on the high seas.

Science, having proved beyond a doubt the serious depletion of the plaice in the North Sea by the operations of man, after having made the fullest allowances for natural seasonal fluctuations, now sets out to suggest practical measures. The most attractive of these is transplantation from overstocked to understocked areas, from coastal grounds to such isolated shoals as the Dogger Bank, which has a peculiarly high capacity for supporting plaice. In this connexion the experiments of Mr. Borley, 1904–8, are now classical. We have, too, the work of Petersen, an annual profit of 100,000 kr. since 1908 against an annual expenditure of 5000 kr., figures for transplantation in certain Danish territorial waters and not for the high seas, open to every nationality. A limit of length, below which no fish could be marketed, would seem to be simpler, but it would have to be considerably higher than 22 cm.—the size proposed before the War by the International Council (this is about the size now considered unprofitable by English trawlers), and indeed higher than 25 cm., which was considered desirable by the Council but not proposed as a practical measure; for neither of these limits would prevent steam trawlers and seiners from visiting the small plaice grounds and killing vast numbers of tiny plaice while in search of other fish. A third remedy, an increase in the size of the net's mesh, is not practicable, for the trawl has to catch round as well as flat fishes.

There remains the formation of reserves, where young fish would grow to marketable size and whence they would spread over the whole North Sea, this clearly being the measure favoured by Messrs. Borley and Pelham as being most certain and effective. They clearly prefer complete closure of these reserves to all classes of fishing—any measure which is the same for all would alone appear tolerable to our fishermen—but partial closure is mentioned. The scientific evidence in our opinion is conclusive, and we regard the whole question as now in the hands of the executive to decide in the first instance whether they will try to do anything or not. If it is determined to make the attempt, Britain must either, with other countries, enforce a size limit, which will almost certainly be ineffective, or, better, endeavour by agreement to close, as a first experiment, a small area to all fishing vessels. Such a closure would undoubtedly be attempted, were there a young plaice ground to the west of the North Sea, near England. Unfortunately the only experimental closure of value would have to be on the east side, the difficulties in respect to which, however, are not insurmountable, provided the English Minister for Agriculture and Fisheries has the courage to propose it as a subject of negotiation between all the countries concerned; he will be in a strong position, for all the fishery experts of these countries are agreed as to its desirability and our

own fishermen clearly see the necessity for remedial measures.

It is certain that the continuance of the depletion of the plaice stock of the North Sea will lead to a complete disorganisation of the steam trawler industry in its southern part. The owners will either have to lay up their vessels or shift them to ports already overcrowded, while the fishermen will have either to "go on the dole" or to push in to some other part of the industry. It is proved that the danger is a real and immediate one, and, as such, it should surely be faced without delay, while remedial measures are still possible.

J. STANLEY GARDINER.

Faculty Organisation at Cambridge.

THE University Commissioners have published for information certain draft statutes that they are considering on the question of faculty organisation in the University of Cambridge. Among many points of interest to those who may be concerned in administering the new scheme, and to those who will have to live and work under it, a few may be mentioned in a brief preliminary survey. Two schools are created for the scientific studies: the School of the Physical Sciences including the faculties of engineering, mathematics and physics, and chemistry, and the School of the Biological Sciences including the departments of anatomy, botany, genetics, geology, parasitology and zoology, which form one faculty, and the departments of biochemistry, experimental psychology, pathology and physiology, which form a second biological faculty. The remaining faculties, which are not purely literary or belonging to the fine arts, are economics and politics, moral science, agriculture, archæology and anthropology, geography and medicine.

The separate faculties consist of the regular teaching staff working in the faculty. Boards of faculties will be formed, corresponding to the present special boards of studies; the duties of the boards of faculties are to be to provide adequate instruction and facilities for research in their departments and to arrange the examinations in their subjects of study. The boards are to determine the remunerations of the members of the faculty staffs, but there is no indication in the draft statutes that they will actually have the power to handle any funds. This is a very necessary power in connexion with such matters as departmental libraries, and provision should be made for it at some point in the statutes.

The new General Board of Studies is to be a smaller body than the present one and to consist, in addition to the vice-chancellor, of four members elected by the boards of the literary faculties acting in common, four members elected by the boards of the scientific faculties acting in common, and four members of the council elected by the council. A considerable amount of work is to fall upon the new General Board in framing and supervising the educational policy of the University. In dealing with problems affecting a particular faculty, the General Board may have a representative of the faculty board present, and in dealing with matters affecting several faculties it may get help from the council of a School, the kind of super-faculty, advocated by Sir Joseph Larmor and others, for which arrangements have been made in the scientific schools mentioned above.

Amongst clauses of interest in the proposed new statutes on the University teaching officers, we may mention the general adoption of the federated superannuation scheme for universities and arrangements for a sabbatical year—one term's freedom from duty for every six terms during which an officer has discharged the duties of a teaching officer. The question of stipend during an absence of not more than a year is left undecided, perhaps necessarily so. Another important point is that women are to be eligible for all teaching offices in the University. Here, presumably, restrictions will have to be imposed in such cases as that of a divinity professorship carrying with it a canonry at Ely. The basic amount of teaching for University lecturers and demonstrators is also laid down, and a minimum is fixed for the basic rate of pay. The amount of teaching that a University lecturer may give on behalf of a college in the way of supervision is limited, and the permission of the General Board has to be obtained for any other teaching given in full term by the lecturer.

In the attempt to separate the recognised lecturer from the private coach, and to limit the amount of teaching that the lecturer may give, there is presumably a desire to keep the lecturer free to carry on research. With this desire general sympathy must be felt. It is obvious, however, that this part of the scheme can only work satisfactorily if the financial side is also capable of satisfactory adjustment. It will want very careful handling and very careful watching if the University is to steer clear of the danger of driving an impecunious, young, but successful teacher out of its official ranks. Close co-operation of the General Board of the faculties with the faculty boards and with the college councils will be very necessary here. The question must be largely a financial one, and full consideration of it must be deferred until the financial side of the faculty organisation has been developed and made available.

The Founders of American Geology and their Work.

The First One Hundred Years of American Geology By George P. Merrill Pp. xxi + 773 + 36 plates (New Haven Yale University Press, London Oxford University Press, 1924.) 27s. 6d net

MR MERRILL has spared no trouble in collecting material for this history. The imaginings of the earliest speculators on the history of the earth, and sketches of their lives and characters are presented almost too liberally, so far as regards the first eight chapters of the book I trust that I shall not appear ungrateful if I say that these chapters leave me with a feeling of bewilderment The geological paragraphs, in themselves disconnected, are mixed up with biographical matter, while the biographical information, scattered here, there, and anywhere, fails to convey a clear idea of what any one man was thinking at any one time. Obviously a strictly chronological arrangement was impossible, for episodes in the development of geology overlap indefinitely, nor did one geologist wait for the death of another before beginning to publish. Nevertheless, if the author, in developing his theme, had concentrated either on the growth of geology, or on the biographies, his work would have had less the appearance of having been made up of extracts from a notebook.

Chapters ix. to xv, on the other hand, are good examples of historical treatment Each is devoted to the discussion of some one of the great problems which have exercised the minds of American geologists. The various stages from the initiation of the problem to the solution as accepted to-day are clearly set out, and the comparative progress made in Europe and America can be realised

The biographical notices, nevertheless, are full of interest Aided by numerous portraits, they enable us to realise what manner of men they were who founded American geology. One is struck at once by the diversity of professions from which the lure of the rocks drew geologists, early and late, in the United States as in Europe. Lawyers, doctors, ministers, engineers, soldiers, politicians, business men, dentists, all contributed. We are deeply impressed, too, by the immensity of the field that awaited exploration by these men. Physical features and geological agencies presented themselves with a grandeur and on a scale for which there is no room in Europe. The effect of such an environment is apparent. American geologists distinguished themselves, as we learn on p. 663, "in studies tending towards the solution of, first, the fundamental problems of continental uplift and depression as made by Dana; second, in those relating to the physics and structure of mountain ranges, made by Rogers brothers, le Conte, and Dana; third, in those relating to glaciers and glaciation by Agassiz and the elder Hitchcock, and later by Chamberlin, fourth, in those relating to isostasy and physiography, made by Dutton, Gilbert, and Powell in the arid regions; and fifth, in those relating to vertebrate evolution, made by Leidy, Cope, and Marsh" As regards glaciation, however, it should be remembered that Agassiz laid the foundations of his theories in Switzerland, the country of his birth, though he further developed them after his transference to the United States.

The book opens with an account of the Maclurean Era, 1785–1819 Maclure, "the William Smith of America," was born in Scotland in 1763. He made a fortune in business and, after travelling extensively in the Old World, he settled in the United States There he not only became a liberal patron of science, but also by his own personal exertions in the field, often under extreme privation, he collected sufficient material to enable him to publish the first geological map of America in 1809

During this era, progress lay chiefly in the hands of men engaged in the so-called learned professions. Mostly self-trained and hampered by the mental attitude of the times, these men were faced by a pathless wilderness of vast extent, inhabited, if at all, by more or less hostile Indians Observations in the field and the collecting of facts were therefore matters of extraordinary difficulty, but speculations on such phenomena as earthquakes and volcanoes, on the origin of glacial drift, on the structure of the globe and other inviting objects, were not lacking. Maclure, as regards his own views, summed up the matter: "All these speculations . can be accounted only as an amusement at present" Men's minds, moreover, were dominated by the belief that the Noachian deluge was a world-wide catastrophe, and that the Scriptural narration of the creation must be taken literally. Thus the bones of a mammoth found at Albany in 1705 clearly corroborated the Scriptural account of a race of antediluvian giants. One may smile at the crudeness of these early speculations, but these men had the sagacity to realise what is not realised by the majority even now, that there were things in the world around them that could be, and ought to be, explained. Yet one almost fears that the author may have been more conscientious than kind in rescuing some of the crudest theorisings from their decent oblivion.

In 1802, when Silliman was appointed professor of chemistry and natural science in Yale, no science was taught in the United States or England. He had some acquaintance with law but none whatever with science, and thus found himself in somewhat the same position

as Sedgwick when he became professor of geology at Cambridge. Yet he did more by his teaching than any other man of his day to advance the science of geology. His name is best remembered by his *American Journal of Science*, founded in 1818 and still continuing. But he made some sagacious observations, such, for example, as his terse description of East Rock, New Haven, as a rock that had been melted and ejected among the superior strata, but never erupted like lava. Its form he attributed to erosion. *Silliman's Journal* was largely concerned with geology, and he resented the rivalry of the *Monthly American Journal of Geology* founded by Featherstonehaugh. The monthly journal, though warmly blessed by Murchison, Conybeare, Sedgwick, Buckland, and Greenough, had but a short life.

The origin of basalt was still being keenly debated in 1816. The Neptunists proved its aqueous origin and the Plutonists its igneous origin, each to their own complete satisfaction. In 1816, Emmons gave up his practice as a doctor and took a post on the Geological Survey of New York. Thence arose the great Taconic controversy, a battle royal that led to the shedding of as much ink as any of our controversies in Britain. It will be noticed later on.

Chapter ii deals with the Eatonian Era, 1820–29 Amos Eaton gave up the law in 1816, when he was forty, and attended lectures by Silliman. Thereafter he travelled thousands of miles, lecturing on natural history and rousing "uncontrollable enthusiasm" He considered "nothing in geology entitled to much confidence, which is purely theoretical," but was not deterred thereby from accounting for the elevation of the continent by a great explosion which rent the crust of the earth in a north and south direction. His great work was the "Index to the Geology of the Northern States," first published in 1818. In 1820 he brought out a second edition, in which many of his earlier opinions were re-stated in his customary emphatic manner. He was a man of forceful character, as might be judged by the portrait forming Plate V.

Scientific methods were now developing. The value of fossils for purposes of correlation, as taught by Cuvier and Brongniart, was being realised, and was tested on the Atlantic Coast Tertiary deposits, hitherto mostly lumped together as alluvium. The igneous origin of trap was adopted from Hutton, Playfair, and Daubeny. Yet at this same time Silliman calculated that the Noachian flood must have risen in America at the rate of 700 feet in 24 hours, on the assumption that the mountains were about 5½ miles high and were submerged by 40 days' rain, with the help of a deluge from the bowels of the earth. The flood proved fatal to the Siberian mammoth and did much other damage. Silliman, as Huxley put it, wrote "with one eye on fact, the other on Genesis."

Chapter iii. introduces the first of five decades of State Surveys, and deals with the years 1830–39. Eaton produced a text-book early in this period, and still strove to harmonise all phenomena with the Biblical account Sixteen State Surveys were founded, nine of them in the years 1836–40 The number of State Surveys founded in the five decades may surprise British geologists, but it must be remembered that though some of the pioneers had had the intrepidity to attack the wild alone, organised bands of independent resources and capable of self-defence were essential. The object appears generally to have been the exploiting of rocks and minerals of economic value

During the second decade, 1840–49, geology found a place in educational curricula The Society of American Naturalists and Geologists was formed in 1847, but was afterwards merged in the American Association for the Advancement of Science, at the first meeting of which geologists took a prominent part It may be noted that the Geological Society of London had been founded in 1807, and readerships in geology at Oxford and Cambridge in 1813 and 1808 respectively. During the decade much progress was made in the recognition in the United States of the principal formations of Europe The interpretation of the structure of the Appalachian Chain by the two Rogers was a notable achievement. In the final report (not published until 1858), H. D Rogers distinguished hypozoic, azoic, and palæozoic, and divided the last into formations named after the period of a day, such as auroral, vespertine, etc., but the European names, Cambrian and Silurian, were preferred He also enunciated his well-known views on the formation of coal and anthracite, but above all he described what is now known as the "overthrust fault" James Hall's views on palæontology at this time are worth recording. "Changes in the lithological features of a rock . . . are usually accompanied by a greater or less change in the nature of the fossils In no case, therefore, are to be overlooked either of the three important facts and characters, viz., lithological character, order of superposition, and nature of contained fossils." He is credited with having written not less than 10,000 pages, and either this or something in his methods roused the antagonism of nearly every palæontologist in America. Dana began to publish in this decade.

The third decade (1850–59) was marked by financial depression and starvation of State Surveys. It was notable for a report by Evans on the Bad Lands, previously almost unexplored. In the vast labyrinth of defiles the bones of extinct animals lay in profusion.

Leidy's description of Evans's specimens was the first systematic account of the world-famed Bad Lands fossils. Emmons, Dawson, and Hitchcock were publishing in the United States; Murchison was bringing out "Siluria," and Lyell his 9th edition of the "Principles," in Europe.

In the earlier part of the fourth decade (1860–69) the Civil War temporarily stopped work, but State Surveys were resumed in 1864. Dana's "Manual" appeared during this decade. In 1859 petroleum had been found in a well at Titusville. Sterry Hunt pointed out that petroleum by virtue of its lightness would be found in the crests of anticlinals, a guiding principle in the search for oil to-day The fifth decade brought further developments in natural gas and oil. Marsh, at his own expense, collected vertebrates in the Western States, among these the remains of toothed birds and extraordinary dinosaurians Stevenson wrote on the Alleghanies and the origin of coal Chamberlin, dissatisfied with petrological nomenclature, proposed abbreviations, such as *qua* for quartz, *fel* for felspar, *mi* for mica. Thus a mica-granite became *fel-qua-mi* or *mi-fel-qua* according to the predominance of the constituents. The names were rejected as uncouth, but for sheer monstrosity it would be hard to beat some of the latest names, such as *phyrowyomingose* or *hornblende-trach-phyro-monzonose*

The second Survey of Pennsylvania in 1874–87 under Lesley emphasised the magnificence of the structures and the great development of Palæozoic rocks in that part of the United States. Lesley, who was outspoken, referring in one of his reports to the chaos that must have prevailed in earliest Archæan times, remarked, "All this . . is only known to God and Dr. Sterry Hunt, who has described it magnificently"

Chapter viii., dealing with the era of National Survey, opens with words that appeal warmly to us, with the War fresh in our memories. "The period of the Civil War had brought to light a considerable number of men for whom the piping times of peace . . . afforded insufficient opportunities. They were men in whom the times had developed a power of organisation and command. They were, moreover, men of great physical and moral courage." This was the material Hayden found available for his territorial surveys, King for his survey of the 40th parallel, Powell for his exploration of the Rocky Mountains, and Wheeler for his work west of the 100th meridian. The expense, however, of keeping so many separate surveys in progress, with inevitable overlapping, impressed on Congress the necessity for consolidation. In 1879 the United States Geological Survey was founded, a service which is unsurpassed for organisation, efficiency, and wideness of scope.

The controversies on fossil footprints and on Logan's Eozoon form the substance of Chapters ix. and x.

Chapter xi. gives the history of the Laramie Question. The Lignitic beds of Hayden, which occupy vast areas, yielded Tertiary plants and Cretaceous dinosaurs. Thus rose a dispute as to the relative value of plants and animals for purposes of correlation. It was pointed out that Cretaceous rocks in Nebraska yielded a flora that had been referred to the Miocene, and again it was suggested that the evolution of plants had been more rapid in America than in Europe, and that this explained the association of European Tertiary plants with American Cretaceous animals. Eventually the name Laramie was restricted to certain beds which were agreed to be Upper Cretaceous.

The Taconic Question, to which Chapter xii. is devoted, occupied men's minds for half a century, and covered the period of the Sedgwick-Murchison controversy on the same formations. Emmons founded the "Taconic System" and declared it to be older than the Potsdam Sandstone. Others disagreed, but Barrande, on the strength of the trilobites, though without knowing the ground, supported Emmons. Dana and Walcott eventually established the true sequence, which had been completely obscured by faults and folds. The "Taconic" of 1842 was distributed among the Lower Cambrian and Lower Silurian of 1903.

Chapter xiii. gives an account of the development of glacial theories. They commence with talk of convulsions, earthquakes, eruptions, etc. Then the Noachian flood was called in to account for everything. But in 1825 Peter Dobson, a cotton manufacturer, made some truly remarkable observations. He noticed that the boulders had been worn smooth and striated on their under sides, as though they had been dragged in one steady position, and he assumed that they had been held and dragged in ice. He could tell also which end had been foremost by the little ridge extending behind any projecting knob of hard material such as quartz. These brilliant deductions attracted no attention until 1842, when Murchison congratulated "American science in having possessed the original author of the best glacial theory." The greatest advance, however, was due to Agassiz, who arrived in America in 1846 and there developed the views he had formed in Switzerland.

Chapter xiv. relates how the method of micro-petrology as initiated by Sorby and developed by Zirkel, was adopted in America in 1873 and became officially recognised as a necessary part of the equipment of a State Geologist.

Chapter xv. on the age of the earth deals with the estimates made by Hutton, Lyell, Playfair, Reade, and

G. H. Darwin in Britain and those of Winchell, Walcott, King, and Gilbert in America. The American estimates varied greatly, but were all far smaller than those made in Europe. Burrell in 1917 restored the balance by an estimate more than three times as large as any of them.

In laying down this book an impression remains of the immense labour which the collecting of such a mass of material must have entailed. The mass indeed is too rich for easy digestion and might have been the better for a little boiling down and arrangement in the earlier chapters. Still the information is all there, available for any one who has the leisure to look for it. The book has been published on the Philip Hamilton McMillan Memorial Fund, and, as the first fruits of her bequest, must be a source of gratification to Mrs. McMillan.

A. STRAHAN.

The Brauner Jubilee Volume.

Recueil des travaux chimiques des Pays-Bas. Publié par la Société Chimique Néerlandaise. Tome 44 (4ᵉ Série, T. 6), No. 5, Mai. *Numéro jubilaire en l'honneur du Professeur Bohuslav Brauner, publié par ses amis et élèves en commémoration de son 70ᵉ anniversaire, 18.55—8 Mai—1925.* Pp 281-628. (Amsterdam: S A. d'Éditions scientifiques D. B. Centen, 1925.)

NUMEROUS friends and pupils of Prof. Bohuslav Brauner, the illustrious Director of the Chemical Institute of the Charles University of Prague, have signalised his seventieth birthday by issuing this splendid volume of researches in his honour. It opens with a most delightful "Hommage au Professeur Bohuslav Brauner" written by Prof. Urbain and entitled "Discours sur les éléments chimiques et les atomes." In this brilliant essay, the author, in tracing the development of scientific research concerning the chemical elements and the nature of the atoms, shows the fundamental character of Prof. Brauner's work in the fields of the rare earths, the atomic weights, and the Periodic System of Mendeléeff. Whilst every one is familiar with Prof. Brauner's long and splendid series of researches on the atomic weights, it is well that the younger chemists of the present generation should be reminded of the fact that he it was who discovered that the old "didymium" was in reality a mixture of two elements, neodymium and praseodymium.

The present volume bears ample witness to the fact that Prof. Brauner has done much more than greatly to advance the science of chemistry by his own researches. He has created and built up a great school of chemical research in the land of the Czechs. On the cover of this Jubilee volume there is a picture of the fine Chemical Institute which was founded by his efforts in 1903, whilst the 348 pages contained between the covers include a large number of very interesting researches carried out by his present and former pupils. Although it may appear perhaps a little invidious to single out any of these for special praise, attention may be directed to the series of ten investigations with the dropping mercury cathode, published by Dr. Heyrovsky (professor of physical chemistry in the Institute of Prof. Brauner) and his collaborators.

Amongst the papers contributed by foreign chemists, one is very glad to see that there are two from England, namely, Prof. H. B. Dixon's investigation on "The Ignition of Carbon Disulphide Vapour and its Phosphorescent Flame," and a paper by Dr. J G. F. Druce on "The Stannonic Acids and Some of Their Derivatives. A New Series of Organic Compounds of Tin."

On his impending retirement from the active direction of the Chemical Institute at Prague, Prof. Brauner will carry with him not only the affection and esteem of his many pupils, but also the highest respect and admiration of chemists all over the world. For upwards of half a century he has held high the torch of science and true learning, and in the annals of chemistry his name and his work will ever be remembered with honour and gratitude.

F. G DONNAN.

British Butterflies.

Natural History of British Butterflies: a Complete, Original, Descriptive Account of the Life-History of every Species occurring in the British Islands, together with their Habits, Time of Appearance, and Localities. By F. W. Frohawk. Vol. 1. Pp. xv + 207 + 36 plates. Vol. 2. Pp. iv + 206 + 29 plates. (London: Hutchinson and Co., 1924.) 6*l.* 6*s.* net.

MR. FROHAWK is well known to naturalists as an admirable delineator and accurate observer of British lepidoptera in all their stages. The present work amply fulfils the expectations of those who knew that the author was engaged upon the task of describing and figuring every British butterfly in all its phases from egg to imago. The work may fitly be termed monumental; for it represents an immense amount of patient labour carried on through a long series of years, and accomplishes what has never been attempted before, namely, a complete life-history of every species of butterfly that has any claim to be considered British. The ground has been partly covered by the works of Barrett, Buckler, and others, but never before has

the assemblage been figured and described as a whole.

The most characteristic feature of Mr. Frohawk's two splendid volumes is the exact and careful description of each larval form in every period of its growth. These details have in all cases been worked out from actual living specimens, and the amount of labour involved in the completion of this task can only be fully appreciated by those who have experimented in the same field. In the case of species that are now extinct in Britain, such as *Chrysophanus hippothoe* and *Zizera semiargus*, or of occasional visitors such as "*Pieris*" *daplidice*, *Argynnis lathonia*, *Vanessa antiopa*, and *Anosia archippus* (*plexippus*), Mr. Frohawk has made use of eggs laid by females obtained from abroad. In spite of all difficulties, the industry and skill of the author have proved equal to the enterprise of describing and figuring, in all these instances, every stage from egg to perfect insect.

It is well known to all students of the lepidoptera that the life-history of the "Large Blue" (*Nomiades arion*) was a mystery which eluded solution by the efforts of every entomologist until the successive discoveries of Mr. Frohawk, the late Dr. Chapman, and Captain Purefoy furnished the key to the puzzle, namely, the extraordinary relations that exist between the larval *arion* and certain species of ant. Of this association an excellent account is given on pp. 144-149 of the present work, and a striking figure, sketched from life, of the larva signalling to the ant when ready to be carried off to the nest of the latter, is provided on a separate plate. It is noteworthy that German larvæ of *C. hippothoe* kept out of doors in England were visited by ants. Many points of bionomic interest in connexion with other species are mentioned in the text.

The artistic skill of the author is well known, and his beautiful drawings have been, on the whole, worthily reproduced. It may, however, be doubted whether the colour-process adopted is the most suitable that could have been chosen for representing very young larvæ of the natural size. Wing-venation also, in the case of small insects, requires a sharper definition than is to be found in some of the illustrations, *e.g.* on Plates 56 and 56A.

The style and get-up of these volumes is in the main excellent. A few slips may be noted: fig. 23 on Plate 12 has no legend; fig. 15 on Plate 37, called a female, must be a male; the "Mazarine Blue" is spoken of as *Lycaena acis* on p. x, and as *Zizera semiargus* on p. xi. An appreciative preface to this fine work has been contributed by Lord Rothschild, whose generous co-operation and continued encouragement are gratefully acknowledged by the author.

F. A. D.

Our Bookshelf.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie. Band III/2: Die Zellmembran. Von Prof. Dr. C. van Wisselingh. Pp. viii+266. (Berlin: Gebrüder Borntraeger, 1924.) 15 gold marks.

BOTANISTS will welcome a general survey on the plant cell membrane from the pen of the Groningen veteran, Prof. C. van Wisselingh. Inequalities of treatment certainly suggest themselves to the English reader when the chemistry of cellulose is handled without citation of Irvine and its physical structure discussed without reference to W. L. Balls (one recent paper is quoted in the appendix); but there is very real compensation in the individual treatment the problems of the cell wall here receive from the viewpoint of a master of micro-chemical method, who avails himself when necessary of the results of as yet unpublished researches.

The usual plan followed in the monograph is a preliminary account of the chemistry of a wall substance, followed by a discussion of its distribution in the cell wall throughout the plant kingdom. As would be expected from the author, the treatment of suberin and chitin is particularly complete, but it is doubtful whether the reactions of the lignified wall have ever been so fully stated before, and the section upon the chemistry of the pectin substances is very full and up-to-date.

Mangin regarded cellulose, pectin, and callose as the three fundamental substances of the plant wall; the importance of pectin is now fully admitted, but van Wisselingh considers that the case for the identity of callose has yet to be made out. For all fat impregnated walls the author reports a new micro-chemical method. Sections are warmed in baryta water for some hours, so that baryta soaps are formed; acids are then released from these and the melting-points of the acids observed with the sections mounted in glycerine.

The section upon the structure and growth of the cell wall is entirely inadequate as a bibliographic treatment, but contains a most interesting statement of the author's own views, in which stress is laid upon the chemical heterogeneity of the wall and the possibility of its micro-chemical demonstration.

Sturly. By Pierre Custot. Translated from the French by Richard Aldington. Pp. 127. (London: Jonathan Cape, Ltd., 1924.) 5s. net.

THE zoologist does not need the aid of a poetic imagination to appreciate the wonderful panorama of marine life with its hosts of interesting phenomena and many absorbing problems. Yet it is not surprising that these things should have stirred the imagination of a man of letters and moved him to weave this delightful phantasy, with a sturgeon as the central figure, and the world of marine zoology as the setting. M. Custot has read widely and well, and has supplemented his extensive reading by constant observation of marine animals in the aquaria at Monaco. Sturly, the hero of this fairy tale, is a young sturgeon, born in the waters of the Rhône, whose life, from the time of his enthusiastic and unsophisticated youth to the crowning act of reproduction, is charmingly told.

His adventures among the denizens of the seas during his migratory periods, his impressions of the beauty of form and colour, the phenomena of symbiosis, commensalism and parasitism, the phosphorescence of the deep sea animals, the bizarre form of others and the art of protective resemblance are made the means of introducing the reader to a survey of the whole field of marine life, pelagic, littoral and deep sea. Sturly, under the guidance of a hoary, wise, old Echinus, sets out to probe the mystery and meaning of life, and the steady development of his education to a realisation of that inexorable law of Nature, reproduction of the kind, forms the real theme of the book.

The bitterness produced by the results of his search are removed by the advent of death when a voice from another world soothes his last hours in this, by a promise of a reincarnation and a fuller life in the next. Thus does Sturly solve the meaning of life. We can forgive the author a few minor zoological errors such as the occurrence of Convoluta at 100 fm., the presence of *Melia tessellata* in the Mediterranean, and the description of a copepod as a wood-louse, in the real charm and simplicity of his allegory. The book was worth translating, and Mr. Aldington has done his work well in face of the many technical difficulties involved in finding the right English equivalent for the many unusual names of animals in the original. The book should stir the reader to a desire for an extended knowledge of marine life.

British Museum (Natural History). Fossil Insects, No. 1: *The British Liassic Dragon-flies (Odonata)*. By Dr. R. J. Tillyard. Pp. 40+5 plates. *Fossil Insects*, No. 2: *Insects from the Coal Measures of Commentry*. By Dr. Herbert Bolton. Pp. 56+3 plates. (London: British Museum (Natural History), 1925.) 5*s*. each.

THESE memoirs mark a new departure in the publications of the British Museum. Instead of waiting for the time when it would be possible to issue a descriptive catalogue of the entire collection of fossil insects, it has been decided to publish shorter memoirs on portions of the collection whenever specialists can be found to undertake the work. The first two memoirs of the series are written by palæontologists not officially connected with the Museum.

The dragon-flies described by Dr. Tillyard are from the Lias of Leicestershire, Warwickshire, Worcestershire, and Gloucestershire—mainly from the "Insect Limestone" of Lower Liassic or perhaps in part of Rhætic age. The larger number of the specimens were collected by the late Rev. P. B. Brodie. Nearly all the species belong to the sub-order Anisozygoptera, which at the present day is represented by a single genus with two species, one found in Japan, the other in the Himalayas.

The Coal Measures of Commentry in the central plateau of France have yielded an abundant and varied insect fauna, ranging from primitive forms to specialised types regarded as the forerunners of dragon-flies. Nearly all possessed a great span of wing relatively to the size of the body. It is pointed out that only very rarely are two or more insect wings alike in venation—an indication perhaps of rapid evolution in Carboniferous times. Both memoirs are well illustrated with plates and text-figures.

Perseus: or, Of Dragons. By H. F. Scott Stokes. (To-day and To-morrow Series.) Pp. 80. (London: Kegan Paul and Co., Ltd., 1924.) 2*s*. 6*d*. net.

To any who wish to read pleasurably of dragons, this book may be commended. The author ranges with a gossiping humour from Glastonbury to ancient Egypt, devoting some attention to Perseus, St. George, the dragons of Rhodes and Bologna, and other dragons of modern Europe by the way. He begins with a chapter on the characteristics of dragons, touches upon the folk-lore themes which occur in dragon stories, such as the supernatural birth, the life-token, the magic weapon, and the rescued maiden, and concludes with a summary of Elliot Smith's theories of the diffusion of culture from a common origin. Incidentally to his reference to the theory that the dragon is a folk-memory of antediluvian monsters, notwithstanding the chronological discrepancy, it may be mentioned that it has been suggested in all seriousness to the present writer that the long-necked dance masks shown in Capt. Hurley's recent film "Pearls and Savages" is a reminiscence of the plesiosaurus!

Leaves from a Naturalist's Diary: with Notes on What to Look for Month by Month. By A. R. Horwood. Pp. 192+4 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 3*s*. 6*d*. net.

MR. HORWOOD has written a nature study book in the form of a calendar. Interesting or salient points in Nature's yearly cycle are dealt with month by month in separate chapters, and at the end of each chapter is a list of the more important and commoner animals and plants to be found in suitable places during that month. This is the most valuable part of the book, and Mr. Horwood has in some cases given his mere list an ecological value by specifying the kind of habitat in which to look for the species listed. Such lists cannot be expected to be complete, but as a guide to the Nature lover they are useful and should also serve as a basis for a diary in which actual records and other data can be kept by observers. This brief survey of the pageant of Nature for a year is pleasantly written in simple and easy language, and illustrated by four photographs and many quite life-like sketches of typical animals and plants.

The Travel Diary of a Philosopher. By Count Hermann Keyserling. Translated by J. Holroyd Reece. Vol. 1. Pp. viii+336. Vol. 2. Pp. 405. (London: Jonathan Cape, Ltd., 1925.) 36*s*. net.

COUNT KEYSERLING'S reflections on the various modes in which human speculative thought has found expression, and his study of the distinctive character which climate and the aspect of Nature in the different countries of the world has impressed on man's religious and ethical feelings, can now be read by the English student in an excellent translation. The book is delightful to read, on account of the extraordinary power of the author to project himself sympathetically into the most opposite modes of thought. The publication of the original work was interrupted by the War, and that disastrous upheaval, with its outburst of hatreds, casts its shadow over a philosophy conceived in the spirit of peace on earth among men of goodwill.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications*]

On the generally accepted Explanation of the Zeeman Triplet on a Quantum Basis.

THE explanation of the simple Zeeman triplet on the basis of the quantum theory ostensibly depends on the application of Larmor's theorem

This theorem may be expressed as follows

Suppose a system of electrons describing orbits under the action of their mutual repulsions combined with any other forces the directions of which pass through an axis. Then if the system be subjected to the action of a uniform magnetic field H along that axis, the motion of the system is such that it may be represented as a possible motion with H = 0 combined with a precessional rotation as a whole around the axis. When the other forces are central this applies to any direction of H as axis.

In the usual way of applying this theorem to the explanation of the Zeeman effect, the tacit assumption[1] is made that after the imposition of the magnetic field the rotating system is the *same* as before with simply the rotation superposed. This assumption is not only incorrect but would also seem open to two further objections, in that (1) the new orbit ceases to be quantised and (2) the total energy is supposed to be altered by the action of a magnetic field on a moving electron.

That the assumed new orbit ceases to be quantised is easily seen by considering a special case of, say, a circular orbit with its plane perpendicular to the magnetic force. The new path is assumed to be unchanged, but the velocity of the electron to be changed by the Larmor effect (which of course agrees with that calculated from the changed radial force Hev). The orbit therefore ceases to be quantised and the quantum law is disobeyed.

It would seem that the most natural way to attack the problem would be by first attempting a discussion of actual orbits. Unfortunately, however, this shows that no effect is to be expected—or if so the magnitude must depend on the square or higher powers of H. We can easily see this by the following considerations of simple cases.

1. Let us suppose the field is imposed by a very gradual increase from zero. The orbits of all electrons will gradually change. As the change is slow we have an adiabatic process and the new orbits will all remain quantised if the original were. But the magnetic field acts transversely on the moving electric charges, and the total energy will therefore remain unchanged. There is thus on the quantum theory no Zeeman effect.

2. Let us suppose the field already constituted and take the case of a circular orbit round a central force in a plane perpendicular to the field H. Then with the usual nomenclature

$$m\omega^2 r = \frac{e^2}{r^2} \pm He\omega r, \quad W = \tfrac{1}{2}m\omega^2 r^2 - \frac{e^2}{r}, \quad 2\pi m\omega r^2 = nh.$$

From the first

$$\frac{e^2}{r^2} = m\omega^2 r\left(1 \pm \frac{He}{m\omega}\right).$$

If we neglect squares of the small quantity $\pm He/m\omega (= x$ say) we may replace the ω in $He/m\omega$ by its value when $H = 0$. Substituting for ω from the third we find

$$\frac{1}{r} = \frac{4\pi^2 e^2 m}{n^2 h^2 (1 - x)},$$

$$W = \frac{e^2}{r}\left(\tfrac{1}{2}\frac{1}{1-x} - 1\right) = \frac{4\pi^2 e^4 m}{n^2 h^2 (1-x)}\left\{\tfrac{1}{2}\frac{1}{1-x} - 1\right\}$$

$$= -\frac{2\pi^2 e^4 m}{n^2 h^2}\frac{1 - 2x}{(1-x)^2} = -\frac{2\pi^2 e^4 m}{n^2 h^2}$$

neglecting x^2 . . . But this is Bohr's value for no field. As this remains unchanged there is no Zeeman effect.

From the above considerations it would appear that the true explanation of the Zeeman effect on the quantum basis yet remains to be given. Doubtless it is to the nucleus that we must look for this. Should, for example, this contain structures analogous to permanent magnets a change of energy by an impressed magnetic force is possible. But it is not the object of the present note to go into this further question.

W. M. HICKS.

[1] Larmor (see "Aether and Matter," p. 343), however, in stating [his theorem expressly gives a warning against this assumption.

On the reported Kβ_4 Line in the X-ray Spectra of Molybdenum and Palladium.

IN a recent publication A. Leide (*Compt. rend.* 180, p. 1203 (1925)) has reported the results of an investigation of the wave-lengths in the K series of X-rays for elements having atomic numbers between 29 (copper) and 53 (iodine). The spectrograph used had a high resolving power so that the β_1 line was separated into its components. The accuracy was increased by a large number of exposures for each measurement. In addition to the well-known lines α_1, α_2, β_1, β_2 and γ or β_2, he has reported in the case of molybdenum (42) and palladium (46), a line β_4, ascribed to the transitions O_{II}, $O_{III} - K$.

Such transitions are permitted by the principles of selection, but transitions from O_I to K are prohibited. The schemes of electron distribution advanced at present (Bohr, Stoner) place no electrons in the O_{II}, O_{III} sub-levels in the normal states of the molybdenum and palladium atoms, but these elements lie in a portion of the periodic table where inner levels are presumably being filled up as electrons are added, admittedly making the actual electron distribution doubtful in the outermost levels. The presence of this β_4 line for these atoms would lead to the following alternatives: Either the O_{II} and O_{III} levels contain electrons before the first 18 electrons have entered the N shell, or we are here dealing with "semi-optical" X-ray lines, *i.e.* electron transfers from virtual orbits only occupied by electrons in atoms excited in the optical sense. Such orbits would presumably be greatly distorted in the atoms in a solid substance. Such semi-optical lines have been previously mentioned by Siegbahn and his co-workers (*Phil. Mag.* 49, 513 (1925)).

It has occurred to me that there may be some uncertainty as to the existence of this line in the K series spectra of molybdenum and palladium. Recently in this laboratory, in collaboration with Miss Alice Armstrong, a rather extensive reinvestigation of the molybdenum K series spectrum has been carried out, using an ionisation spectrometer. Some of the results of this work were reported to the American Physical Society at its spring (1925) meeting. In the course of the investigation no evidence was found for the presence of this β_4 line described by Leide, though readings were taken in that region of the spectrum in which it should occur. In this region, however, a discontinuity in the white or general radiation always appeared, due to the absorption by

the target of its own radiation This showed itself, for example, in the first order by the fact that the base-line due to general radiation was always much lower on the short wave-length side of the γ line than on its long wave-length side.

This absorption by the target of the radiation which leaves it has been mentioned by other authors, including Walter (*Zs. f. Physik*, 20, p. 268 (1923)) This effect of the *K* critical absorption in the target substance would produce, in spectra of high resolution, a narrow shelf of constant intensity on the short wave-length side of the γ line, followed by a large decrease in intensity on the short wave-length side of the critical absorption wave-length, which is very close to the γ line It seems possible that such an effect might be mistaken for a faint line on the short wave-length side of γ, lying between γ and the critical absorption wave-length The lines reported by Leide were very faint and the wave-lengths given lie within 0·06 per cent. (about 12 seconds of arc) of the accepted values for the *K* critical absorption limits The *K* critical absorption wave-length lies about 45 seconds of arc from the γ line in the first order. Due to the importance which may be attached to the presence of this line in molybdenum and palladium, it is to be hoped that the possibility of confusion on the photographic plate with the absorption limit itself may be removed SAMUEL K ALLISON.

Jefferson Physical Laboratory,
Harvard University,
Cambridge Mass., U.S.A.

A Substitute for a Liquid Air Trap for Mercury Vapour in Vacuum Systems.

As is well known, the speed and simplicity of the mercury vapour condensation pump has led to its almost universal adoption in the production of extremely high vacua. It suffers from the disadvantage that, while it rapidly removes gases and vapours from the vessel to be exhausted, it does not remove mercury vapour,. Consequently, it is necessary to freeze the mercury vapour in a trap between the pump and vessel to be exhausted, by immersing the trap in liquid air. The cost of making liquid air, the difficulty of getting it in certain laboratories, and, in some researches, the need for keeping the mercury trap in action for several weeks without a break, suggested the desirability of looking for some alternative method.

In our search for an alternative method, we have found that the alkali metals have an extraordinary power for absorbing mercury vapour, and may therefore be used as a mercury trap in place of liquid air. Our practice is to put a small piece of sodium or potassium (a gram is ample) into a trap between the diffusion pump and the apparatus to be exhausted, and to distil it, after the vacuum has been obtained, on to the sides of the trap, thus lining it with the metal for a few centimetres. The trap may be of the usual liquid air type, or it may be merely a bent tube with the metallic lining of distilled metal distributed over the inside surface at and near the bend.

Using an ionisation gauge for the vessel to be exhausted, we have found that the pressure of mercury vapour in it with a potassium-lined trap between it and the pump is certainly less than 5×10^{-9} mm. We have made direct comparisons between the trapping power of a potassium-lined tube and that of the usual liquid air trap, the same ionisation gauge measuring the pressure reduction. We have found that the potassium-lined trap is quite as satisfactory as liquid air. The residual pressures obtained in various tests seem to depend entirely upon the vigour with which the ionisation gauge and connecting tubes were outgassed by heat treatment before the measurements were made, and not at all upon whether liquid air or metallic potassium is used to trap the mercury We are convinced that the lowest pressure obtained, namely, 5×10^{-9} mm., is partly, and possibly nearly all, due to residual gases owing to insufficient heat treatment, and that this figure is merely an upper limit to the vapour pressure of mercury in a vacuum system beyond a potassium-lined trap.

The passage of several litres of moderately dry air at atmospheric pressure over the potassium has no serious effect on its power to trap mercury vapour, although one might well have feared such would be the case from the discoloration of the surface produced by the air.

From a practical point of view, it is of importance to know how long the alkali metals retain their power to act as a mercury vapour barrier. In one test, in which sodium was the active metal, the pressure in the ionisation gauge beyond the trap after twenty-five days was within 50 per cent of its initial value (2×10^{-7} mm). We do not know whether to attribute this slight pressure increase to loss of absorbing power by the metal, or to gradual evolution of gas.

In a second test, we used the first appearance of mercury lines in the spectrum of helium, at less than 0·01 mm. pressure, as a criterion of the diminution of the trapping power of a potassium-lined trap for mercury vapour The mercury lines did not appear until the eleventh week, in which time the potassium had absorbed a little more than 150 per cent of its own weight of mercury

A full account of this work will be published in the *Philosophical Magazine*.

A. LL. HUGHES.
F. E. POINDEXTER.

Washington University,
Saint Louis, U.S.A.,
May 18.

The Oogenesis of Lumbricus.

IN a recently published number of the *Quarterly Journal of Microscopical Science*, Mr Leslie Harvey, of the department of zoology of the Imperial College of Science, London, has given an account of the cytoplasmic inclusions of the egg of Lumbricus Mr Harvey describes yolk formation in this animal, and, on the basis of his work on this one form, criticises my previous investigations on Limnæa, and, by inference, that of my pupils on certain other forms. He merely quotes an old paper of mine, remarking a little discourteously that "a glance at this paper will show that really very little is known about the formation of yolk." He has not mentioned my recent work on Saccocirrus, the only other annelid studied by modern methods, nor has he read Dr. Rogers Brambell's more recent paper on "Yolk" in the *British Journal of Experimental Biology*, where the collected observations of several of my associates are discussed ably, the molluscan oogenesis re-investigated, and the general views on yolk-formation held in this laboratory stated.

Mr. Harvey's main criticism is that he cannot find any metamorphosis of Golgi bodies into yolk in Lumbricus, and that therefore my work on Limnæa and that of my pupils on Patella is under suspicion. Mr. Harvey puts himself in the position of a man who, on the strength of a study of the anatomy of Lumbricus, denies the results of another man who has found a radula and a shell in Patella. Before entering into a criticism of my work on Patella, which has been confirmed and extended by Dr. Ludford and Dr.

Rogers Brambell, he should have examined that form itself, or some other such mollusc.

Regarding the special question of the oogenesis of Lumbricus, it is remarkable to note that Mr Harvey has hit upon one of those rather uncommon animals that have no proper vitellogenesis The egg of Lumbricus has no real yolk, but the embryo is nourished in the cocoon by some albuminous substance It is therefore doubly unfortunate that Mr. Harvey should discredit my work, and that of my associates, on the results obtained by the study of this special atypic annelid. Moreover, had Mr Harvey read my results on Saccocirrus, he would have noted that I did not claim in that animal that yolk arose from the Golgi elements Regarding the origin of yolk from Golgi elements, I may mention that Dr P Weiner, of the histology laboratory of the University of Leningrad, recently wrote to me that in Myriapoda and Arachnoidea "he had occasion to observe the starting of yolk granules in contact with particles of the Golgi apparatus," and in this connexion some Julus preparations which I have just seen support Dr Weiner's interpretations Mr Vishwa Nath claims that in Lithobius, and Palamnæus, fatty yolk arises from the Golgi elements In the Julus preparations of Mr Vishwa Nath the Golgi elements of the egg are found to swell up in a specially definite manner, which is not seen in anything like the same degree in Lithobius, where both Miss King and Mr Vishwa Nath agree that the heavier yolk is nucleolar in origin

The complete details of the behaviour of the Golgi apparatus of the Lumbricus oogonium and oocyte, and a discussion on the cytoplasmic inclusions in the eggs of molluscs, annelids, and arthropods, will shortly be given in a joint paper by Mr Vishwa Nath and myself J BRONTË GATENBY

Trinity College, Dublin,
June 4

Band Spectra of Lead Isotopes.

No satisfactory explanation seems to have been given as yet of the measurements made by Grebe and Konen (Grebe and Konen, *Phys Zeits.*, 22, p 546 (1921)) on the band spectra of lead isotopes They observed that, in the case of uranium lead, the lines of the band at 4270 showed an average shift to the violet of 0 055 Å, as compared with those of ordinary lead, and that the lines were much sharper in the former case than in the latter

A very satisfactory explanation is obtained if the carrier of the band is assumed to be, not the heavy Pb_2 molecule, but the lighter PbH molecule. The success of Kratzer (Kratzer, *Ann d Phys*, 71, p 70 (1923)) and of Mulliken (Mulliken, *Phys. Rev.*, 25, pp 119, 509 (1925)) in accounting for the bands in the spectra of certain metals on the assumption of a hydride molecule seems to favour the same assumption in the case of lead.

Applying the theory first proposed by Loomis (Loomis, *Ast. phys Jour.*, 52, p. 248 (1920)) to explain the complex structure of the band spectrum of hydrogen chloride, one obtains, for the wave-length difference between the bands of the hydrides of uranium lead (At Wt. 206 0) and ordinary lead (At Wt 207 2),

$$\frac{d\lambda}{\lambda} = \frac{1}{2}\left(\frac{1}{206} - \frac{1}{207\cdot2}\right) = 1\cdot4 \times 10^{-4}.$$

Since $\lambda = 4270$ Å, the expected shift is 0 060 Å, a value in very good agreement with the observations. The lack of sharpness of the lines in the case of ordinary lead is of course connected with the fact that the atomic weight 207·2 is only a statistical average.

Further, the moment of inertia of the carrier agrees very well with what we should expect for the PbH molecule. The frequency of the lines in the band can be written

$$\nu = A + 2Bm + Cm^2 \quad . \quad . \quad . \quad (1)$$

where m is an integer and

$$B = \frac{h}{8\pi^2 J}, \text{ and } C = \frac{h}{8\pi^2}\left(\frac{1}{J'} - \frac{1}{J}\right),$$

J and J' being the initial and final values of the moment of inertia of the molecule.

Now the approximate constancy of the frequency difference between successive lines, combined with the fact that m is always small for the strongest lines of a band, shows that the last term in (1) may be neglected, compared with the second The mean frequency difference between successive lines is thus equal to $2B$ Since the mean wave-length difference is 1 25 Å, we easily obtain, on substituting numerical values,

$$J' = \frac{h}{4\pi^2 \cdot 2B} = \frac{h}{4\pi^2 d\nu} = 8\,0 \times 10^{-40}$$

For PbH this gives a distance between nuclei of $2\,2 \times 10^{-8}$ cm in good agreement with what we should expect from crystal data The radius of the Pb atom, according to the measurements of Owen and Preston (Owen and Preston, Proc Phys Soc Lond, 35, p. 101 (1923)), is $1\,76 \times 10^{-8}$ cm To obtain the same moment of inertia with a Pb_2 molecule we should have to assume an incredibly small distance between nuclei

We may therefore conclude that the carrier of the lead band at 4270 Å is in all probability the PbH molecule. ETIENNE S. BIELER.

Macdonald Physics Building,
McGill University, Montreal, Canada,
May 15.

Petroleum in Uganda.

My statement, which is quoted in part in NATURE for May 23, p. 815, in the columns of Research Items, under the title "Petroleum in Uganda," with reference to large quantities of oil in the Albertine depression is, I fear, on account of its separation from the context, the omission of seven words and the contributor's remarks upon it, likely to be misunderstood by those who have not read my report, and indeed may possibly deter some from reading the report at all.

I am well aware that the mere occurrence of seepages can never be any criterion of the existence of recoverable supplies; but in that part of the report from which the quotation is taken I am discussing oil formation, not oil accumulation, upon which successful exploitation depends. The results of our chloroform tests (referred to in the seven words missing from the quotation) are sufficient to establish the validity of my general statement as to quantity, quite apart from seepages: quantity is one thing, a recoverable supply is another.

Because more than one British dependency in Africa is at present trying to decide whether it will or will not have a geological survey, the contributor's supposition expressed in the last four lines of the item under consideration would appear unfortunate. Is it not wise to be hopeful, and to remember that some rift valley oil fields are already known?

E. J. WAYLAND.

MR. WAYLAND clearly shows in his excellent report that petroleum has formed in the Lake Albert depres-

sion, and I quoted from him to this effect. I consider, however, that neither seepage nor positive result of chloroform tests constitutes sufficient grounds on which to discuss "magnitude" of such formation, hence the omission in the quotation of six (not seven) words concerning these tests does not affect my comment. Regarding future prospects of petroleum development in Uganda, I agree with Mr. Wayland that it is wise to hope, since hope (unlike oil) springs eternal, but I still feel that the storehouses of petroleum of which he speaks may prove to be like the famous cupboard of the nursery rhyme, though this may be due to my conceptions of the laws governing distribution of oil within the earth's crust being somewhat different from those of Mr. Wayland. On the other hand, it is to be hoped that those responsible for initiating geological surveys in British dependencies are actuated by wider considerations than the possible chance of finding oil; there are other natural resources in the world besides petroleum, and this, quite apart from an obvious scientific motive, should be adequate economic reason for the governments concerned to follow the good example of Uganda.

THE WRITER OF THE NOTE.

Paramagnetism and the Electronic Configuration of the Atom.

IN a recent note [1] Foëx has directed attention to the fact that two samples of a paramagnetic salt, well defined chemically and placed in identical conditions, can possess very different magnetic properties, apparently corresponding to distinct states of the paramagnetic ion in the salt. This diversity of the magnetic states has been known for some time for the case of solutions of the salts [2] Thus a concentrated solution of ferrous ammonium sulphate exists in four states: 26 magnetons with a positive molecular field, 26 5 without an appreciable molecular field, 27 and 27·5 with a negative molecular field.

It now appears that the same salt can exist in two distinct magnetic states also for the solid substance, one with 26 magnetons and a positive molecular field,[3] and another with 27·5 magnetons and a scarcely appreciable negative molecular field.[4] Similarly, anhydrous cobalt sulphate can exist in two magnetic states. Thus the measurements of Théodoridès,[5] Ishiwara,[6] and Jackson,[7] all indicate one state with 25 magnetons, while Honda and Ishiwara [8] found a variety with 24 magnetons and a very small positive molecular field.

The differences can scarcely be attributed to experimental errors or to impurities present in the salts. It seems highly probable that these salts can actually exist in two forms which are identical so far as chemical composition is concerned but are different magnetically.

Russell [9] has recently suggested that the active and passive states of iron, nickel, and cobalt may correspond to different structures of the atom. Thus he supposes that, while active iron possesses an electronic configuration of 2, 8, 14, 2 in the 1st, 2nd, 3rd, and 4th quantum orbits respectively, passive iron may correspond to either of the arrangements 2, 8, 13, 3, or 2, 8, 15, 1. Similarly, active nickel may correspond to the configuration 2, 8, 16, 2, and passive nickel to 2, 8, 17, 1.

It is here suggested tentatively that the different magnetic states of the ions of iron ($Fe^{\cdot\cdot}$) and cobalt ($Co^{\cdot\cdot}$) may also correspond to different internal configurations of the electrons. Thus the ordinary ferrous ion would possess the configuration 2, 8, 14_0, and the other magnetic state might be produced by the transference of one of the fourteen electrons in the incomplete 3rd quantum orbit to the 4th quantum orbit, or by a redistribution of the 3rd quantum orbit electrons among the various levels, 3_1, 3_2, and 3_3, of this orbit.

If this were the case, it would be expected that the solid salt or solutions of the salt would possess different absorption spectra when existing in the different magnetic states. This point could readily be tested, and the results would serve to confirm or refute the suggestion.

L. C. JACKSON

The Davy-Faraday Laboratory,
The Royal Institution,
London, W.1, May 23.

[1] *Comptes rendus*, 1925, 180, 919.
[2] *Ann. de Phys.*, 1911, 16, 174.
[3] Ibid.
[4] Measurements of Kamerlingh Onnes and Oosterhuis and of Jackson. See Jackson, Phil. Trans., 1923, 224, 1.
[5] *C. de Phys.*, 1922, 3, 1.
[6] *Sci. Rep. Tohoku*, 1914, 3, 303.
[7] Loc. cit.
[8] *Sci. Rep. Tohoku*, 1923, 4, 213.
[9] *Nature*, 1923, 112, 452.

A Luminous Spider.

ONE day in Central Burma the trail in the jungle was exceptionally difficult. It was long past noon when I realised that the return journey would be equally long and tiring. Camp lay on the other side of a long range of hills, and there was a short cut from the main trail that would save several miles, but this trail was faint. I reached the supposed cut-off about dusk and followed it upward Darkness came on swiftly, and my pony began to stumble. Somewhere we had missed the trail, for at intervals I could still glimpse the crest of the hills, and I knew my general direction.

Fireflies sparkled here and there. Presently a few feet away I saw a ball of light as large as one's thumb. It was stationary. Tying the horse, I approached it as carefully as possible, finding it surrounded by thorny bushes. It did not move, and I pressed the brush aside until I was directly over it, and then struck a match There, in full view, was a spider, its large oval abdomen greyish, with darker markings. Still it did not move, and as the match died out its abdomen again glowed to full power, a completely oval light, similar in quality to that of the fireflies. Remembering native tales of poisonous insects, I wrapped a handkerchief around one hand, parted the brush with the other, and when close enough made a quick grab. Alas! the handkerchief caught on a stick before I could encircle the spider, and my treasure scurried away. I followed as quickly as possible, but the light soon disappeared under stones, brush, or in some burrow, for I never saw it again.

Many nights I searched in the jungle and questioned natives and white officers who had passed through that district, but apparently no one else had reported a luminous spider, nor can I find record of any known elsewhere.

Burmese never leave their houses after dark on account of their fear of spirits, so it is not surprising that the natives had never seen one, but some other traveller may be so fortunate as to capture one of these spiders.

The place where I saw the specimen was between the villages of Kyawdaw and Thitkydaing, Pakkoku District, about one hundred and twenty miles west of Mandalay, Burma, in April 1923.

BARNUM BROWN,
Associate Curator.

Department of Vertebrate Palæontology,
American Museum of Natural History,
New York City, May 29.

The Relations between Sunspots, Terrestrial Magnetism, and Atmospheric Electricity.

By Dr. C. CHREE, F.R.S.

THE existence of a relation between sunspot frequency, or area, and the phenomena of terrestrial magnetism and atmospheric electricity is a question on which a reasoned statement of opinion may be opportune.

Two elements may be connected and yet not stand in a linear relationship. When nothing is known, there are advantages in a graphical method, such as that employed by W. Ellis[1] when comparing diurnal magnetic ranges at Greenwich with Wolf's sunspot frequencies But when there is reason to anticipate a linear relationship, it is better to use Wolf's formula

$$R = a + bS,$$

where S denotes sunspot frequency, and R is a quantity such as the diurnal range of a magnetic element a and b are constants which can be determined by least squares. Obviously a is the value of R when $S = 0$. As the average range of S between sunspot maximum and minimum approaches 100, $100b/a$ is a convenient measure of the importance of sunspot influence. In the case of magnetic daily ranges $100b/a$ usually exceeds 0·5, and not infrequently 1·0. If $100b/a$ is a small fraction, the sunspot influence, even if real, is unimportant. The closeness with which Wolf's formula fits the observations is measured by the correlation coefficient r. As b shows the sign of the correlation, whether positive (*i.e.* element increasing with S) or negative, we shall treat r as a numerical quantity. It cannot exceed 1, which represents a perfect fit. A low value such as 0·3 implies that the sunspot relation is very doubtful.

In the case of terrestrial magnetism, a linear sunspot relation seems fairly established for the range of the regular diurnal variation, whether of declination (D), horizontal force (H), or vertical force (V). Further claims have been made. Thus Leyst[2] believed the secular change of D to be considerably faster at sunspot maximum than at sunspot minimum, but further investigation has not confirmed this. Declination may be east or west, and numerically increasing or diminishing; thus acceleration of the secular change signifies different things at different places. *A priori* the force components H and V seem more likely to possess an 11-year period. Unfortunately, with ordinary instruments, H and V determinations are less reliable than those of D, and it is doubtful whether the annual values available have the accuracy necessary for determining the reality of a sunspot influence, which is certainly not large.

Diurnal range may signify the range of a diurnal inequality based on hourly values, or the difference between the extreme instantaneous values of the day, usually called the absolute range. In most if not all of the earlier work by Wolf, Ellis, and others, range meant the diurnal inequality range, or some analogous quantity. Older data were mostly from eye readings taken at two fixed hours, at Milan, for example, at 8 A.M. and 2 P.M. If the observation hours are the hours of maximum and minimum in the mean diurnal inequality for the year, they will give in the case of the whole year the same range that hourly readings give. If the hours of maximum and minimum vary in different months, the range derived from hourly readings may in some months sensibly exceed that from readings at two fixed hours. But these are minor differences, and the older observations may be regarded as establishing the validity of Wolf's formula for the mean diurnal inequality of the year. In general, D was the element considered, but Ellis also included H. It is not claimed that Wolf's formula with invariable values of a and b agrees closely with observation in every year of, say, 50 years. But, so far as is known, whenever Wolf's formula has been applied to any 11 years, b has proved to be plus, and $100b/a$ has been substantial. This has been true whether the diurnal inequality has been derived from quiet days or from ordinary days. At Kew the value obtained for $100b/a$ from the quiet days of 1890 to 1900 was 0·71 for D, and 1·07 for H. Ordinary days gave very similar results. Fairly similar results have been obtained at many stations, the value of b/a being usually decidedly higher for H than for D. The fit of Wolf's formula is generally good, and sometimes extremely close. For the period 1911 to 1921, in the case of the mean diurnal inequality at Kew, r was 0·96 for D, and 0·95 for H.

Instead of the range of the mean diurnal inequality for the year, we may take the arithmetic mean of the ranges of the diurnal inequalities for the 12 months. The two quantities usually differ, but similar results are obtained.

Instead of considering the whole year, we may apply Wolf's formula to different seasons, or even individual months of the year. The fit for an individual month, *e.g.* the Januaries of an 11-year period, may be indifferent, but it is usually good for a 4-month season, *e.g.* May to August (summer), or November to February (winter). We may calculate a and b from the range of seasonal diurnal inequalities, or we may accept as the seasonal values of a and b the arithmetic means of the a's and b's calculated for the included months separately. The most outstanding result is that, at least in higher latitudes, b/a is considerably larger for winter than for summer. Thus at Pavlovsk, 1890 to 1900, the value of $100b/a$ for H from all days was 1·77 in winter, as against 0·98 in summer.

The absolute daily range is larger than the inequality range, and is more affected by disturbance. It, too, shows the sunspot influence clearly, but with a less close fit of Wolf's formula. An interesting example[3] is afforded by the years 1892, 1893, and 1894, with sunspot frequencies of 73·0, 84·9, and 78·0 respectively. The ranges of the mean diurnal inequalities in D at Kew for ordinary days were 9′·85, 10′·7, and 9′·8; while the mean absolute ranges from all days were 17′·7, 15′·6, and 16′·5. Thus 1893, the year of sunspot maximum, had the largest inequality range, but its mean absolute range was distinctly inferior to those of the adjacent years. The result appeared in H as well

[1] Phil. Trans., 171, p. 341.
[2] *Bull. de la Société Impér. des Naturalistes de Moscou*, 1909, p. 160.
[3] Phil. Trans., A 206, pp. 215 and 226; A 216, p. 161; and Chree, "Studies in Terrestrial Magnetism," pp. 177, 178.

as D, and the order of the inequality ranges was the same for quiet as for ordinary days.

The difference between sunspot maximum and minimum years is partly a matter of disturbance, but both classes of years contain days practically free from disturbance, and the quiet days from sunspot maximum years tend to have larger ranges than the quiet days from sunspot minimum years. The relation between sunspots and magnetic disturbance is much less definite than that between sunspots and the regular diurnal inequality. In a general way, disturbance is least at sunspot minimum. In the 11 years 1890 to 1900 at Kew there were 29 (Greenwich) days with H absolute ranges not less than 250γ, but none of these occurred in the three years nearest to a sunspot minimum. On the other hand, some years of many sunspots are also quiet. For example, 1893, a year of sunspot maximum, had no H range so large as 250γ, while 1892 and 1894 between them had 24 such ranges. Again, some of the very largest magnetic storms have occurred in years of comparatively few sunspots. Thus 1921, with a sunspot frequency little more than half that of the average year, had a succession of highly disturbed days during May, to which the previous 60 years afforded only one parallel.

The existence of a specific relation between individual sunspots and individual magnetic storms is a vexed question, on which a general agreement cannot be claimed. The magnetic character of an individual day certainly cannot be inferred from the sunspot area or frequency for the day. The 660 selected quiet days of the 11 years 1890 to 1900 had 41·15 as their mean provisional sunspot frequency, as compared with a mean of 41·03 from all days of the year. When the 5 days of highest sunspot area from each month of these 11 years were considered, the corresponding mean daily H range at Kew exceeded the average from all days by only 3 per cent. Most magnetic storms last only one or two days, few so much as four days; but a large sunspot is seldom so short-lived as this. The natural inference is that if the sunspot is the immediate cause of the magnetic storm, its effectiveness must be largely restricted to one particular stage of its development, or else to a very limited range of position relative to the earth. The investigation above referred to suggested an enhanced diurnal range in H for some days subsequent to the attainment of a maximum sunspot area on the sun, the largest range appearing 4 days subsequent to the maximum area.

The phenomenon most suggestive of an influence associated with specific small solar areas is the 27-day interval in the sequence of magnetic storms The interval seems well established, and its most natural explanation, as suggested by Mr. Walter Maunder, is the existence for a number of solar revolutions of a comparatively narrow cone of radiation which sets up a magnetic storm whenever it crosses the earth. A difficulty is that the 27-day interval seems as well established for quiet as for disturbed conditions. A curious phenomenon, some cases of which were recently discussed by Father Cortie,[4] is that after a number of recurrences of disturbed conditions at 27-day intervals, quiet conditions intervened, to be succeeded by further sequences of disturbed conditions. On the other hand, when we proceed by 27-day steps from a selected quiet day, we sometimes hit on a highly disturbed day. These phenomena suggest the possibility that a limited solar area may emit a radiation, which at one stage enhances and at another stage diminishes the ionisation of the upper atmosphere. If the radiation consisted at one stage of free ions, and at another stage of ejected matter which loaded up the ions naturally present in the upper atmosphere, the 27-day interval in quiet conditions would be intelligible. This suggestion was made originally in a frivolous spirit, but it may be more worthy of consideration than was originally supposed.

The possibility of a sunspot influence in atmospheric electricity seems to have occurred independently to several people, including the present writer.[5] It has recently been the subject of two papers by Dr. L. A. Bauer.[6] In the first of these, which dealt with the potential gradients recorded at the Ebro Observatory, Tortosa, he concluded that mean yearly values of potential gradient (P) and its diurnal range both increased with sunspot frequency. As a check, the writer[7] applied Wolf's formula to five sets of Kew potential gradient data, from two periods 1898 to 1909, and 1910 (or 1911) to 1920 (or 1921). The results were so far favourable to Dr Bauer's conclusions in that a positive value of b resulted in four cases. But the fifth case gave a negative value, and the values of $100b/a$ were all small, the four positive values averaging only +0·17, and the corresponding values of r averaging 0 49.

In his second paper (*l c.* p 186) Dr. Bauer expresses somewhat modified views, including

(*a*) "The probability is high that . . potential gradient and its diurnal and annual ranges . . are subject to sunspot influence"

(*c*) "During 5 of the past 7 sunspot cycles the potential gradient and ranges generally increased with increasing sun-spottedness. For the remaining 2 sunspot cycles, the potential gradient and ranges . . . apparently decreased with increasing sunspot activity."

The epochs in which the relation is supposed to have been negative seem to be 1845–1855 (station Brussels) and 1886–1897 (stations Perpignan, Lyons, and Greenwich).

Some knowledge of the observational uncertainties is a desirable prelude to a consideration of the results. Suppose we take a water-dropper, the most efficient type of "collector." When the electrograph is working, the tube discharging the jet is connected to the needle of a quadrant electrometer. One pair of quadrants is maintained at a constant potential $+v$, and the other pair at $-v$, the sensitiveness varying with v. Suppose we break the connexion to the jet, and connect the needle to a variable source of potential. Raising the potential step by step, put marks on the paper on the recording drum answering to the voltages 100, 200, etc. Now remove the source of potential, and connect the needle to the discharge tube. For simplicity, suppose the air surrounding the jet to remain for some time at +100 volts. On turning the jet on, the electrometer reading gradually rises, reaching a stationary

[4] Proc. Roy. Soc. vol. 106, p. 19.

[5] Phil. Trans., A, vol. 206, p. 303

[6] *Terrestrial Magnetism*, vol. 27, p. 1; vol. 29, pp. 23 and 161.

[7] Proc. Physical Society, vol. 33, p. 129.

position in, say, 30 seconds. But the reading answering to the stationary position will be sensibly less than 100 volts, unless the insulation of the water tank and discharge tube is really good, and the deficiency is greater the poorer the insulation and the less efficient the collector.

Again, the potential at the site of the collector is usually a good deal lower than it would be at the same height above level ground remote from buildings. Thus, however good the insulation, the readings require multiplication by a factor to give true potential gradients, and unless the position of the collector and its environment (and the insulation of the water-dropper) are invariable, the factor varies with time.

The necessity for a reduction factor was generally unrecognised until comparatively recently, while changes calling for alteration in the factor are practically certain to have occurred in the older installations. Insulation is very hard to maintain good, especially with the older types of insulators. It generally suffers from damp weather, and some years are much damper than others. The outcome is that unless a reduction factor is regularly determined and applied, the absolute potential gradient and its diurnal and annual ranges, as deduced from the curves, may fluctuate as insulation is better or worse. They will also naturally alter with the growth of trees or shrubs, or modification of buildings near the collector.

Kew has probably a longer record from a fairly modern electrograph than any other observatory, and Dr. Bauer has suggested the utilisation of the earlier records. The curves prior to 1898 were unfortunately not tabulated, with the exception of one or two years, and the heavy labour required to do so now has not appeared justifiable in the absence of determinations of a reduction factor before that date.

To gauge the probability of Dr. Bauer's conclusions, his notation and methods must be understood. He employs two formulæ:

$$P - P_m = s'(S - S_m) \quad . \quad . \quad . \quad . \quad (A),$$

and

$$P - P_m = s(S - S_m) + t(T - T_m) \quad . \quad . \quad (B).$$

Here S represents Wolf's sunspot frequency, P the absolute value or the range of potential gradient, T the year, and the suffix m denotes the mean for the period considered. s', s, and t are constants determined by least squares. (A) is simply a variant of Wolf's formula, with s' written for b. (B) differs through the addition of a term varying linearly with the time. The correlation coefficient is called r', in the case of (A) and r, in the case of (B). Dr. Bauer attaches most weight to (B), but gives no adequate justification for its use. The question is important because r, is usually larger than r',, so if (B) is admissible the case for a sunspot influence appears stronger than it otherwise would. Cases are conceivable in which (B) would be justified, *e.g.* if besides an 11-year period there were a much longer period, say 100 years, or if some gradual change had been in progress in the apparatus or its environment, which might reasonably be supposed a linear function of the time. But some positive justification seems called for in each specific case. The fact that the t-term usually improves the agreement with observation is no sufficient argument in its favour, because, with two constants at our disposal instead of one, that is only to be expected. When t is small, s and s' differ but little, but when it is large, they usually differ considerably in size and sometimes even in sign. Large values of t appear more especially in the older series of observations used by Dr. Bauer, especially those for St. Louis, Perpignan, Brussels, and Greenwich. But they also occur in the case of some of the more recent data, including some from Kew. In 4 out of 7 cases at this station in Dr. Bauer's Table 5, p. 169, *l.c.*, s is positive, while s' is negative. In fact, the adoption of the two-term formula converts a vote against to a vote for a positive correlation.

One most important modern station, the uncorrected data from which might have called for a t-term, is dismissed by Dr. Bauer in the following words (*l.c.* p. 24): "Unfortunately as regards the Potsdam observations, various changes . . . especially during the period 1914–19 when no control observations . . . could be made, have introduced discontinuities . . . so as to make unsafe the utilization of the observations." This view has recently been controverted by Dr. Kahler, of Potsdam,[8] who claims that the mean annual values of potential gradient now published are satisfactory. Dr. Kahler adds that they do not support a sunspot influence, but he gives no figures. As the Potsdam series is longer than most, and the station has a high reputation for staff and equipment, it has seemed desirable to apply a Wolf's formula to the mean yearly values given by Dr. Kahler, treating them on parallel lines with data from Kew and Eskdalemuir. The results from the three stations are as follows, the unit for a and b being 1 volt per metre:

Quantity	Period.	Station	a.	b	100 b/a	r.
Mean annual value	1904–23	Kew	309	+0·303	+0·098	0·37
,, ,, ,,	,,	Potsdam	211	−0·216	−0·102	0·34
,, ,, ,,	1911–21	Kew	312	+0·444	+0·142	0·56
,, ,, ,,	,,	Potsdam	205	−0·143	−0·069	0·46
,, ,, ,,	,,	Eskdalemuir	236	+0·440	+0·186	0·83
Range mean annual	1911–21	Kew	152	−0·114	−0·075	0·23
Diurnal inequality	1912–21	Eskdalemuir	110	+0·115	+0·105	0·25

The year 1911 was omitted in the final case at Eskdalemuir owing to some special uncertainties.

One of the outstanding things was the opposition between the Kew and Potsdam data from 1911 to 1921. At Kew the departures of S and P from their mean values agreed in sign in 9 of the 11 years, while at Potsdam they differed in 10.

Referring to Dr. Bauer's own tables of results, there seem to be only three of his stations—Tortosa and Eskdalemuir with at most 14 years' observations, and Kremsmunster with only 8—which supply in all the cases considered positive values for s and s', and several of these values are quite small.

The data from Kew and Potsdam are suggestive either of no direct sunspot influence, or of a comparatively trifling influence liable to be masked by weather effects. Less conflicting results may be obtainable from regions having a less variable climate, but lower latitudes have been as yet very poorly represented.

A sunspot influence acting in different directions at

[8] *Ergeb. der met. Beob. im Potsdam in den Jahren 1921, 1922, und 1923*, p. viii.

different places at the same time, and affecting the results at one station in opposite directions at different epochs, is something quite unlike the sunspot influence recognised in the diurnal variation of terrestrial magnetism. Its acceptance does not seem justified without much more observational support than it has yet received.

Some remarks in § 47 of Dr. Bauer's second paper (*l.c.* p. 184), if they stood alone, or even if they followed the conclusions on p. 186, might be interpreted as not inconsistent with the conclusions reached here. If, however, he really regards the existence of a sunspot influence in atmospheric electricity as quite an open question, a more explicit statement is desirable, as several recent references to his work assume a relation to have been established.

Note added June 3.—Since the above was in print, a further paper by Dr. Bauer has appeared in the March number of *Terrestrial Magnetism*, in which he dissents from Dr. Kahler's conclusions.

An International Campaign against Sleeping Sickness.

AMONG the limited number of post-War changes that it is possible to regard with satisfaction, not the least is an enhanced sense on the part of representatives of European nations of their responsibilities towards what are known as native races. Conspicuous manifestations of this new spirit have been shown by the British Government, and recent action on the part of the League of Nations is evidence of similar breadth of view. In 1922 the Provisional Health Committee of the League appointed a Committee of Experts, under the chairmanship of Dr. Andrew Balfour, for the purpose of collecting information as regards sleeping sickness and tuberculosis in equatorial Africa, and making certain recommendations with reference to these diseases. The members of the Experts Committee, in addition to the chairman, are Dr. E. van Campenhout, Director of the Public Health Service at the Belgian Ministry of the Colonies; Prof. Gustave Martin, formerly head of the French Sleeping Sickness Mission in French Equatorial Africa; and Dr. A. G. Bagshawe, Director of the Tropical Diseases Bureau, London. This Committee, which met for the first time in November 1922, submitted to the Health Committee of the League two most valuable Reports; and the outcome of the recommendations included in the second of these was an International Conference on Sleeping Sickness, which assembled last month in London, and was presided over by Mr. W. Ormsby-Gore, Under-Secretary of State for the Colonies. All of the countries interested in tropical Africa, namely, Belgium, France, Great Britain, Italy, Portugal, and Spain, were represented at the Conference by well-known authorities on tropical disease.

As most people are already aware, thanks to the prominence given to the matter by the daily press, among the recommendations that the delegates to the Conference have unanimously decided to make to the Council of the League of Nations, and to their respective Governments, is the formation of a small international commission for the investigation of sleeping sickness problems in Africa itself. It is suggested that this Commission shall consist of a few specialists in tropical disease furnished by the Powers interested in Africa, with the addition of a biochemist and an entomologist with local knowledge; and that it shall also include the well-known authority Dr. K. Kleine, the value of whose recent researches in Northern Rhodesia and elsewhere on the therapeutic effect of "Bayer 205" is widely recognised.

Since Uganda and the regions adjacent to Lake Victoria furnish the most suitable field for the study of the problems selected, it is proposed to make Entebbe the headquarters of the Commission, and to place the latter under the presidentship and control of Dr. H. Lyndhurst Duke. The necessary expenditure, to which the respective Governments, the Health Organisation of the League of Nations, and scientific research institutions of certain countries, are to be invited to contribute, is estimated at some 10,000*l.* It is suggested that the Commission shall assemble at Entebbe at the end of next December, or in January 1926, and that it shall work for twelve months, after which it will submit a special report to the League of Nations Experts Committee. Guided by Dr. Duke, the Commission will apply itself in the first instance to a study of "the research methods and laboratory technique at the Entebbe Institute and its field laboratories, as well as the field work and measures taken against sleeping sickness in the Protectorate of Uganda and the infected districts of Tanganyika."

After inspecting the methods and highly promising results of Mr. C. F. M. Swynnerton's experiment in the control of *nagana*-carrying tsetse-flies at Shinyanga, Tanganyika Territory, the Commission will settle down to "joint laboratory investigations as to the methods of work which are most suited for research into the several problems referred to it" by the Conference. It is understood that these problems include, among others: the question of the existence, nature, and determining factors of any human immunity to trypanosomiasis; the comparative value from various aspects of trypanocidal agents; the function of wild and domestic animals as breeding grounds for the virus; and the possibility of *Trypanosoma gambiense*, the causal agent in trypanosomiasis as conveyed by *Glossina palpalis*, assuming the form known as *Trypanosoma rhodesiense*, and so becoming capable of dissemination by *Glossina morsitans*.

In addition to its proposals for the Commission, the International Conference has also advised the adoption of a number of highly important administrative measures, including arrangements for periodic official conferences, and frequent interchange of information between administrative and medical officers on both sides of boundaries between infected countries; the devising of means for giving legal effect to recommendations of the medical service engaged in the campaign against sleeping sickness; and methods for the control and reduction of trans-frontier native traffic in infected areas.

It must not be thought that, at the present time, before the proposed International Commission is yet in being, little or nothing is being done by the governments and medical services concerned to combat

sleeping sickness Sleeping sickness and *nagana*, the kindred disease of domestic stock, are scourges which in greater or less degree, according to the physical and other conditions of localities, affect or threaten all countries and peoples in tropical Africa wherever the insect carriers of trypanosomes, the various species of Glossina or tsetse-flies, exist that is to say, within roughly parallel lines drawn from the Senegal River to Somaliland, and from the southern boundary of Angola to Zululand in the south-east In Africa to-day the tsetse-fly problem, with its contingent maladies, is more important than any other, and, in addition to its direct effect upon human life, is more than anything else retarding progress and development Thus all European nations with a stake in the African continent, all those represented at the recent Conference, are vitally affected, and all are keenly alive to their danger.

Fortunately, with regard to sleeping sickness in general, there is no need to sound an alarmist note Although in the Mongalla and Bahr el-Ghazal Provinces of the Anglo-Egyptian Sudan, into which the disease has recently been introduced from French Congo, Belgian Congo and Uganda, the position is one of some anxiety, and though elsewhere, as in parts of Cameroons, French Equatorial Africa and Belgian Congo, there are foci of varying intensity, in no country nowadays is there anything comparable to the great epidemic of sleeping sickness that started on the northern shore of Lake Victoria in 1901. In the course of this outbreak the population of the districts affected, originally about 300,000, was reduced by two-thirds in six years The energetic methods taken to combat the disease, including wholesale removals of natives, closing of areas, and clearing of lake and river margins, are too well known to need recapitulation. Their success is shown by the results detailed by Dr G D Hale Carpenter, Senior Medical Officer in charge of Sleeping Sickness, Uganda, in his Report for 1920–21. In the course of a tour of inspection covering some 1750 miles, Dr. Carpenter examined no fewer than 54,600 natives, among whom he found only 264 cases of sleeping sickness

Since the Uganda outbreak, the campaign has been waged energetically, often with a large measure of local success, not in British dependencies alone, but also in those of almost all other countries as well It is impossible to read the Reports of the Committee of Experts, to which reference has already been made, without being filled with admiration for the work carried out by the medical services and administrations concerned. In the matter of sleeping sickness, as it affects the native populations of Africa, "the white man's burden" has been shouldered with goodwill. In French Equatorial Africa the labours of the medical services, often sadly handicapped by insufficiency of personnel and equipment, and in the face of difficulties which only those familiar with the conditions of tropical African travel can fully appreciate, have been directed especially towards the systematic *atoxylisation* of the sick. This line of policy not only effects a proportion of cures in the early stage of the disease, but also—what is even more important—by removing the trypanosomes from the peripheral blood, prevents persons already infected from endangering their neighbours by way of the local tsetse. By means of this system excellent results have already been obtained, and in some instances great epidemic foci appear to have been stamped out; the method has already been introduced into Uganda by Dr. Carpenter. In the case of African natives, however, it is often difficult to ensure that no sick person contrives to escape examination by a medical officer on tour; and in this connexion it may be noted that the appointment, in threatened districts, of special administrative officers to deal only with sleeping sickness affairs, as is already the practice in the Lake Victoria area of Uganda, was urged emphatically by Dr. Carpenter in 1923

Without entering further into the technicalities of the campaign against sleeping sickness as at present conducted, or dwelling upon well-known methods for the local abolition of *Glossina palpalis*—the most formidable but by no means the only tsetse-fly carrier of the disease—it is hoped that enough has been said to indicate some at least of the conditions as they now exist, before the appointment of the International Commission At the recent meeting of the second Imperial Entomological Conference, at which the tsetse-fly problem was discussed, Dr. Andrew Balfour referred in optimistic terms to the beneficial results likely to accrue from "the association for a considerable time of two such brains as those of Dr. Kleine and Dr. Lyndhurst Duke". On the same occasion it was pointed out by Mr. Ormsby-Gore that the Commission is bound to have great educative value, not only on public opinion in Europe, but also on local administrations in Africa. We heartily wish it success.

E. E. A.

Current Topics and Events.

In February 1825, Faraday was appointed director of the laboratory of the Royal Institution, and his first act after appointment was to invite the members to evening meetings in the laboratory These evening meetings developed into the Faraday evening discourses which have remained a feature of the Institution unto this day It was accordingly very appropriate that the celebration of the centenary of the discovery of benzene by Faraday should be inaugurated on June 12 by the Friday evening discourse on "Faraday as a Chemist" by Sir William Pope Elsewhere in this issue we print Sir William Pope's discourse together with papers read on the occasion of the centenary celebrations on June 16. Sir William Pope first referred to Faraday's youth and early scientific training and then passed on to a brief discussion of his chemical investigations. Faraday analysed caustic lime from Tuscany, repeated and extended E D Clarke's work on the oxy-hydrogen blowpipe, and he burnt diamonds. He discovered the substances now known as hexachloroethane, tetrachloro-ethylene, and hexachlorobenzene before he isolated benzene in 1825. Steel alloys and optical glass were studied for several years and a large number of gases were liquefied for the first time He determined the composition of naphthalene and investigated the action of chlorine on benzene in sunlight, in this way discovering *p*-dichlorobenzene.

Gold films, solutions of colloidal gold and electrochemical researches nearly complete the list of his chemical investigations. Sir William Pope laid stress on the significance of the discovery of benzene in view of later important technical and scientific developments, and he referred to the marvellous suggestiveness of much of Faraday's work. He also described Faraday's pre-eminence as an experimenter, his greatness as a scientific theorist, his versatility, and his innate but undeveloped mathematical ability. The fruit of Faraday's labour has not yet all been gathered; a hundred years hence the Friday evening lecturer will have an even more wonderful tale to tell of discoveries inspired by the work and thought of Michael Faraday.

A SMALL but interesting exhibition has been arranged and is now on view at the Science Museum, South Kensington, commemorating the centenary of the discovery of benzene by Faraday. Amongst the exhibits shown at the Science Museum are two original specimens of benzene, prepared and labelled by Faraday, which were bequeathed to the Museum in 1911 by Mr. H. L. Barnard—it will be remembered that Faraday married Sarah Barnard—and an autographed photograph of himself which was bequeathed to the Museum by Miss Jane Barnard. The original cabinet in which Faraday stored the specimens of benzene and which contains many other specimens of his chemical discoveries, including the polished weldings of steel and platinum and the alloys produced with Mr. Stodart in 1821 in the search for a non-rusting steel, is also on view. Other interesting exhibits show the importance of benzene to the synthetic dye industry and illustrate the distillation of coal-tar, from which benzene is obtained on a commercial scale. A series of models of the principal space formulæ proposed for benzene, showing the relative space arrangements of the atoms within the molecule, is not only instructive but emphasises the importance with which benzene has been regarded since the time of its discovery.

THE trial in the United States of Mr. Scopes, for teaching evolution in a State-supported Tennessee school, promises to become a *cause célèbre*. It is attracting widespread attention, and a bewildering array of legal authorities has been enlisted on both sides. The defence is being financed by the American Civil Liberties Union, which has secured the help of many distinguished barristers, including Mr. Bainbridge Colby, a former Secretary of State in Wilson's cabinet. He will be supported by numerous advisers representing the Modernists, the champions of free speech, and scientific experts. Mr. W. J. Bryan will take part as one of the counsel for the prosecution. The Tennessee Text Book Commission has introduced a new text book of biology for use in the State schools, which states, in reference to animals resembling man, that "none of them are to be thought of as a source or origin of the human species." Take no thought of the past as well as of the morrow seems to be the desire of the Fundamentalists as to the history of man.

THE leading article in NATURE of June 6 on "An Imperial Research Committee" contained reference to the possible effect of the salt-tax in India on the efficiency of the native population, the suggestion being that the taxation of this vital commodity had the effect of reducing its consumption. Dr. F. Maitland Gibson, lately director of the King Institute of Preventive Medicine in Madras, in a letter to the editor dated June 13, takes exception to this statement. During his twenty years' residence in India the salt-tax was never higher than one halfpenny per pound. The daily physiological requirement of salt per head of the population addicted to a vegetarian diet has been estimated at 30 grains. On that basis, the effect of the tax on the consumption of salt should be negligible. Even if the consumption of salt far exceeded physiological requirements the effect of the tax would scarcely be felt even by the poverty-stricken Indian, and should be a smaller factor in reducing consumption than the manipulation of prices by salt dealers. Dr. Gibson would probably agree, however, that political and psychological factors must also be taken into account in connexion with this tax. For political reasons—for example, non-co-operation—the Indian might refuse to buy any salt, while the fact that a certain commodity is taxed, to whatever amount, might also lead to greatly reduced consumption by peoples living continuously on the poverty-line. But whatever the effect of this particular tax, it can be argued that it is wrong in principle to tax vital commodities before other and more equitable means of raising revenue have been exhausted.

AN appeal has been issued from Government House, Nairobi, for subscriptions to the Coryndon Memorial Fund, with which it is proposed to improve and to extend the existing natural history museum in the Kenya capital. This is an object which should not only make its appeal to scientific workers on its intrinsic merits, but also because the late Sir Robert Coryndon was probably unique among British colonial governors in his appreciative understanding of the importance of scientific research and the educative value of carefully selected and properly cared for exhibits of naturalists. In spite of the pressing problems involved in the administration of the most difficult colony in British possession, he found time, in the year preceding his tragically sudden death, to make a comprehensive survey of the Victoria Nyanza territories and to furnish a stimulating and invaluable report to the Secretary of State for the Colonies, in which he stressed the importance of a unified research service for the Lake area. A few years before, while Governor of Uganda, he gave an impetus to medical and veterinary research, and to him can be attributed the growth of the scientific spirit in that Protectorate. Reference has been made already in NATURE to the appeal he made on November 20 last year to his fellow-countrymen for support for the Amani Institute. This formed part of a general plea for more generous encouragement of scientific research. The fact that on that occasion he specifically commended the enlargement and proper equipment of the Nairobi Natural History Museum to the attention of his

audience as a worthy object for support lends emphasis to the appropriateness of the projected tribute to his memory. His life was devoted to the service of the British Empire, and he had the highest conception of the function which science fulfils in its development.

In connexion with our note of last week on Dr J. W. L. Glaisher's jubilee of fellowship of the Royal Society, it is of interest to recall a long-forgotten episode as to the assistance he gave fifty years ago towards the publication of Peter Gray's "Tables for the Formation of Logarithms and Anti-Logarithms to Twenty-four or any less Number of Places," an 8vo work issued in 1876. Gray states that he allowed some manuscripts of his to lie by for a number of years owing to printing difficulties. At length an abridgment of his papers was made and communicated to the *Assurance Magazine*. These papers were afterwards collected and published in 1865. This tract, after some years, came under the notice of Mr. T. Warner, F.R.A.S., of Brighton, who opened a correspondence with Gray, and finally offered a most handsome contribution towards the expenses of printing the whole set of tables. Having (he says) mentioned the circumstance to two gentlemen interested in such matters, they each offered quite spontaneously a liberal contribution in supplement of Warner's gift. The two who gave this gratifying proof of interest were Dr. J. W. L. Glaisher, F.R.S., and Mr. H. D. Hoskold, a mining and civil engineer of Dean Forest, Gloucestershire. Dr. Glaisher made a number of valuable suggestions in the course of printing.

Lawrence Rooke, astronomer and mathematician, who died on June 27, 1662, was an active member of the group who were concerned in the promotion of experimental philosophy. He was chosen to succeed Samuel Foster in the professorship of astronomy at Gresham College in 1652, and in 1657, upon Dr. Whistler's resignation of the chair of geometry at the College, was permitted to exchange that of astronomy for it. Educated at Eton, he was for a while at Cambridge, but in 1650 he transferred himself to Wadham College, Oxford, with the view of studying under Dr. Wilkins, then Warden, and Dr. Seth Ward, the Savilian professor of astronomy. It will be recalled that it was after one of Wren's lectures at Gresham College, in 1660, that the company "withdrew for mutual conversation into Mr. Rooke's apartment," there to discuss a project for a new college or society for physico-mathematical learning. At a meeting of the Royal Society on June 13, 1661, Rooke was desired to bring in a relation of the satellites of Jupiter and the height of the atmosphere. Next month he read his paper of observations of the eclipses of the satellites of Jupiter, for which thanks were given him. On October 9, 1661, Rooke, with Croune and Dr. Pope, were appointed a committee to view propositions for inquiries in foreign parts.

Rooke's death, in his fortieth year, had a tragical aspect. The Marquis of Dorchester, who had a great regard for him, was accustomed to entertain him at Highgate, bringing Rooke by coach on Wednesdays to the Royal Society's meetings at Gresham College. One day in the heat of early summer, Rooke walked into London (so we are told) and "took cold, which occasioned a fever, and that put an end to his life at his lodgings in Gresham College," on the very night, which he had for some years awaited, wherein to finish accurate observations of the satellites of Jupiter. So intent was he to the last upon completing his theory of that planet, wanting but one observation more (which might be made on the night of his death) to perfect that theory, he desired Dr. Pope to go to the Royal Society and request some person to do it. The Bishop of Exeter (Dr. Ward) intended to erect a monument to his memory, but instead of that gave the Royal Society, in memory of his friend, a large pendulum clock, by Fromantel, which was set up in the actual room at Gresham College where the circle of philosophers met, afterwards it was removed to the hall of the Society in Crane Court, Fleet Street.

After an absence of four weeks, Captain Amundsen's aeroplanes returned to Spitsbergen on June 18, having reached lat. 87° 44′ N., long. 10° 20′ W., a distance of 136 miles from the Pole. Amundsen's preliminary account of the journey is published in the *Times*. The aeroplanes on leaving Spitsbergen encountered fog for a few hours, and when the weather cleared, were too far west. A more easterly course was laid, but it was decided to land in order to get definite bearings before continuing the flight, since at 1 A.M. on May 22, after eight hours' flying, half the petrol had been consumed. The only possible landing place was a water lane through the pack. Both planes were gripped in the ice, but eventually, after 24 days' work, one of them was released. It showed signs of strain but was undamaged. With a greatly reduced load it was possible to start this machine from a levelled stretch of ice on June 15. In 8½ hours, North Cape of Spitsbergen was reached, and there a passing sealer was met and carried the explorers to King's Bay. To the farthest point the planes flew 621 miles at an average speed of 93 miles per hour. Capt. Amundsen believes that but for a head wind causing leeway, he could have reached the Pole with the petrol he carried. The two 370 h.p. Rolls Royce Eagle IX. engines of each aeroplane worked without a hitch. The geographical results of the expedition are practically confined to a sounding of 2051 fathoms at the place of descent. This confirms the conception, founded on Nansen's work, of a deep polar basin and dispels any probability of land on the European side of the Pole.

The members of the Inter-State Post-Graduate Assembly of America visited Edinburgh on June 18-20. On June 18 the visitors assembled in the M'Ewan Hall, where an address of welcome was given by the Vice-Chancellor of the University, Sir Alfred Ewing, following which the honorary degree of LL.D. was conferred on Dr. Charles H. Mayo of

Rochester, Minnesota During the three days clinics were arranged in the Royal Infirmary in the departments dealing with medicine, surgery, gynæcology, and the diseases of ear, nose, throat, and eye There were also clinics in the Sick Children's Hospital and the Maternity Hospital Demonstrations and exhibits were arranged by members of the staffs of the departments of surgery, midwifery, pathology, bacteriology, and tropical diseases of the University and of the laboratory of the Royal College of Physicians An evening reception was given on June 18 by the Lord Provost, Magistrates and Council of the City at Inverleith House, kindly placed at their disposal by Prof Wright Smith, Regius keeper of the Royal Botanic Garden, Edinburgh, and a visit was made to the historical apartments in Holyrood Palace on the afternoon of June 19

THE Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik at Munich, described in our issue of April 25, p 611, was opened on May 7 with every mark of national rejoicing The Museum, as its name implies, is devoted to applied science, and has for its aim the spread of knowledge of the great discoveries and inventions upon which rest the material civilisation of to-day The festivities commenced on Tuesday, May 5, with a procession of allegorical cars, representing the principal branches of science, through the decorated streets of the city On the day following the business meeting took place and was attended by ministers, mayors of large cities, leading industrialists, representatives of the Verein deutscher Ingenieure, of the universities, and of some foreign countries, the representative from England was Mr H W Dickinson of the Science Museum, South Kensington On May 7 a symbolical play, specially written for the opening by Gerhart Hauptmann, Germany's leading living poet, was performed

THE Museum building, commenced in 1906, is an imposing structure, to the designs of Gabriel and Emanuel von Seidl, situated on an island in the river Isar. In plan the building is roughly 100 m square, and the whole ground floor is occupied by exhibition space, but in the three floors above, a well 60 m square gives the necessary lighting. The floor space amounts to about 35,000 sq metres At one corner is a tower 64 m. high, and there are three domes devoted to astronomy The exhibits have been chosen with good judgment Very great use is made of interiors, and as examples we may mention a scythe forge of 1803 from the Black Forest, the alchemist's laboratory of the middle ages, and a paper-mill of 1708 With these may be classed realistic representations of stone, ore, coal, and salt mining situated below the floor level of the Museum Nor must mention of the planetarium in the astronomy section be omitted By projection apparatus images of the fixed stars, or of the sun, moon, and planets, are thrown on a domed ceiling, and their apparent motion over a long period is reviewed in a few minutes The apparatus has created the keenest interest, and several similar instruments have been ordered; we should like to see such an apparatus set up in Great Britain. The Museum is in no sense a State institution, but owes its existence mainly to the labours of Ing Dr Oskar von Miller, a well-known electrical engineer, now in his seventy-first year It is a monument of what can be done by personality, scientific knowledge, ordered imagination, and organising ability, even when interrupted by the War, the subsequent revolution, and the inflation of the currency

THE Department of Scientific and Industrial Research is carrying out a series of investigations into adhesives Some of this work has direct industrial application, some of it is of the nature of purely scientific research, *e g* investigations into the chemistry of gelatin and the mechanism of adhesion It is hoped that the more strictly scientific investigations will enlarge the present range of industrial application It has now been suggested by a prominent firm in the industry that it should be brought into closer contact with the fundamental scientific work, and it is prepared to contribute towards the cost The Department has accepted this suggestion and is prepared to make similar arrangements with other interested firms for this part of the work, and to furnish progress reports from the Committee in charge, on the understanding that they will on their part communicate any information of general interest they may obtain from their own investigations based upon the results of the Committee's researches Particulars of the scheme can be obtained from the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S W 1

ONE of the main functions of the Fuel Research Board of the Department of Scientific and Industrial Research is a survey and classification of the coal seams in the various mining districts by means of physical and chemical tests in the laboratory, supplemented where desirable by large scale tests at H M Fuel Research Station, East Greenwich, or elsewhere The Board has decided that the best way to carry out this work is by means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain, as well as outside scientific interests Each committee is charged with the duty of supervising the work of the physical and chemical survey in a coal mining area, and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able to estimate most correctly the relative importance of the problems to be solved The seams selected undergo physical and chemical examination by local investigators appointed for the purpose, after which a final selection is made of those seams likely to justify experiments on a technical scale in order to test their suitability for particular uses or methods of treatment. Committees have for some time been actively at work in the Lancashire and Cheshire and in the South Yorkshire areas, and another committee has recently been appointed to deal

with the North Staffordshire area. The North Staffordshire Colliery Owners' Association and the North Staffordshire Institute of Mining Engineers are co-operating in the work.

THE British Museum (Natural History) is to be congratulated on the rapid progress which is being made with the issue of its series of picture postcards illustrating various aspects of natural history. The latest additions include two further series in colour of British birds (summer visitors), an additional two series, also in colour, of British flowering plants, a set of restorations of fossil reptiles, a group of British Crustacea, and a series illustrating colour change in flat fishes, the last three series in black and white. Of these, the most interesting, because perhaps the most original, are those of the fossil reptiles. They are reproduced from drawings made by Miss Alice B. Woodward, and are remarkably natural in their general effect, suggesting a much less virile and more decadent group of animals than the majority of restorations tend to convey. The cards are admirably and clearly reproduced, and maintain the high standard set by their predecessors.

THE Trustees of the British Museum have published a second edition of the valuable handbook to the ethnographical collections which has been out of print for some little time. Mr. T. A. Joyce is again responsible for the text—in this edition with the assistance of Mr. H. J. Braunholtz. Where necessary the text has been modified to bring it into agreement with the growth of anthropological knowledge since the first edition was published in 1910, and a certain amount of supplementary matter has been added. The most considerable addition, however, is in the illustrations. Eighteen text-figures have been added, making two hundred and ninety-three in all, and five plates, bringing the total number up to twenty. Of these illustrations the most interesting are those figuring additional examples of African art, and in particular may be mentioned the very fine ivory mask from Benin. Notwithstanding the increased cost of printing, the price of the handbook has been raised from two shillings to two and sixpence only. Even in the board covers which have taken the place of the cloth of the earlier edition, this is remarkable value.

THE report for 1924 of the Director of the National Botanic Garden at Kirstenbosch, South Africa, records a gallant struggle to continue the development of this wonderful garden site near Cape Town in the face of great financial difficulties. It is, however, regrettable to learn that during the year expenditure upon the Garden, already ridiculously small, had to be cut down owing to reduced revenue, the Government contribution to revenue remaining at the same figure as previously. The University of Cape Town has now established the Bolus Herbarium at Kirstenbosch on a site allotted by the Trustees of the Garden, so that facilities for scientific work on the spot are considerably improved. During the present year, with aid from the Government on the pound for pound principle, the Harold Pearson Memorial Hostel should be completed, with accommodation for a lady warden and about ten residents and servants.

THE Kew Hand-Lists of Herbaceous Plants were issued in the first place to show what species are actually grown at Kew, and also to reduce, if possible, the nomenclature in use in gardens to something like a standard. Possibly on account, particularly, of this second aim, the Kew Hand-Lists have always been found of very general use, and the second edition of the Hand-List of Herbaceous Plants, issued in May 1902, has long been out of print. A new edition appeared in January of this year, but this appears as three lists, (1) Herbaceous Plants, (2) Rock Garden Plants, (3) Hardy Monocotyledons. A new edition of the Hand-List of Trees and Shrubs (excluding Coniferæ) grown in Kew has also been prepared. This list has been revised in accordance with the International Rules of Nomenclature.

THE subject of climatic changes is arousing great interest in the United States at present, and is being attacked along several different lines. Palæoclimatology is a borderland science; it lies between meteorology, geology, botany, and zoology, and no specialist in only one of these subjects can be fully qualified to deal with all aspects of the problem. It is a case for team-work, and we accordingly welcome the publication, in the *Scientific Monthly* for May, of a series of papers read at the December meeting of the American Association for the Advancement of Science on the subject of "Ancient Climates." Meteorology is represented by Dr. W. J. Humphreys, who gives an account of the possible causes of climatic changes, and glacial climatology by Dr. E. Antevs, while S. S. Visher presents an account of Huntington's "Solar-cyclonic hypothesis." Prof. A. P. Coleman deals with the geological aspects of ice-ages, Dr. T. W. Stanton reports on the Mesozoic invertebrates, and Dr. David White discusses the plants of the Upper Palæozoic. The papers are sufficiently interesting taken by themselves, and are rendered more so by their juxtaposition, but the reader is not given any help in considering their bearing on each other. We should like the authors to have met round a table afterwards, and to have formed themselves into a committee with power to co-opt representatives of other sciences such as chemistry and astronomy. A joint report by such a committee would be of outstanding importance in the study of ancient climates.

THE Academy of Sciences of Russia will celebrate its bi-centenary at Leningrad and Moscow between September 6 and 14 next. Foreign representatives are being invited and will receive special hospitality.

A SPECIAL general meeting of the Royal Astronomical Society will be held in the rooms of the Society on Friday, July 24, at 4.30 P.M. It is hoped that a number of foreign astronomers who will be in England in connexion with the meeting of the International Astronomical Union will be present and will speak about their work.

MR. L. S. AMERY, Secretary of State for the Colonies, has consented to receive at the Colonial Office, on

July 7, a deputation which will discuss with him the question of the further development of the work of the Imperial College of Tropical Agriculture for the whole Empire The deputation, which will be introduced by Lord Burnham, will be of a thoroughly representative character.

WE much regret to announce the deaths of Mr W. J Dibdin, formerly chief of the Chemical and Gas Department, London County Council, and a leading authority upon the subject of purification of sewage by micro-organisms in contact and slate beds, on June 9, aged seventy-four years, and of Mr. D B Dowling, geologist on the Canadian Geological Survey since 1891, who was known for his work on the formation of coal, aged sixty-six years

ACCORDING to the Singapore correspondent of the *Times*, the Council of the King Edward the Seventh College of Medicine has announced that the Rockefeller Foundation has presented to the college 350,000 dollars for the endowment of chairs of bacteriology and biochemistry, on condition that the Government founds an extra chair of biology and agrees to equip and maintain the three departments

THE seventy-eighth annual meeting of the Palæontographical Society was held at Burlington House, London, on June 19, Mr E T Newton, president, in the chair In the annual report of the council, regret is expressed at the decreasing support received from English public libraries and local societies, but the renewal of subscriptions from the countries of central Europe and new subscribers from the United States of America are noted. New monographs of the Upper Eocene Flora and of Dendroid Graptolites were announced Prof. H. L. Hawkins and Messrs L R. Cox, A W Oke, and G W Young were elected new members of council Mr. E T Newton was re-elected president, Mr. Robert S Herries was re-elected treasurer, and Sir A. Smith Woodward was re-elected secretary

LORD BALFOUR is to deliver the presidential address at the statutory meeting of the recently formed Institute of Philosophical Studies, to be held at the Royal Society of Arts on June 29 at 4 30 The Institute has the patronage of an imposing array of names. The objects are excellent but very indefinite as set forth in the only prospectus we have received If the aim of philosophy is " to see life steadily and to see it whole," and if the directors in furthering this aim propose " to disentangle our beliefs from a confused jumble, and to purify them of a great many irrelevancies," it would be useful if they would give some definite idea of their mode of procedure The Institute does not propose to compete with the universities, though it will arrange lectures in all branches of philosophy and encourage research in any of its departments

BULLETIN No. 12 (1924) of the New South Wales Department of Mines deals with coke and the by-products arising from its manufacture. The text contains numerous statistics and is well illustrated by photographs. After a brief historical introduction, the various coals and types of ovens are described, followed by detailed descriptions of the coking process as carried out in various Australian works

WE have received a copy of Circular No 12 of the Engineering Experiment Station of the University of Illinois, entitled " The Analysis of Fuel Gas " The pamphlet gives a description of the apparatus developed at the University of Illinois for the purpose of analysing fuel gas, and contains a synopsis of the methods best adapted to this type of apparatus These methods are in the order of procedure necessary for carrying out the analysis. A comprehensive review of methods to be used with other types of apparatus is included in the appendix of the circular, which may be obtained from the Engineering Experiment Station, Urbana, Illinois

THE April catalogue of Mr C Baker, of 244 High Holborn, London, W C 1, contains full descriptions of more than 2500 pieces of second-hand scientific apparatus. The photographic section, which was included in recent catalogues, has been omitted, and is to be published as a separate pamphlet in accordance with the pre-War custom The present catalogue is noteworthy on account of the wide selection of astronomical instruments offered for sale These include reflecting and refracting telescopes, mounted both equatorially and in the altazimuth manner, transit and meridian instruments, object glasses and eyepieces, mirrors and flats, stands and mountings, sidereal clocks, etc The number of instruments of each type is exceptionally large, the equatorial refractors, for example, numbering twelve, and ranging in aperture from 3-in to 8-in , and in price from 35*l* to 595*l*. A 7-in Cooke photo-visual refractor with accessories is included All the instruments advertised are guaranteed to be in adjustment

APPLICATIONS are invited for the following appointments, on or before the dates mentioned —A part-time assistant-lecturer (woman) in hygiene (infant welfare work and personal hygiene) and demonstrator in bacteriology at King's College for Women (Household and Social Science Department), Campden Hill Road, W 8—The Secretary (June 30) Two assistant lecturers (one with special qualifications in science) in the department of education of the University College of the South-west of England, Exeter—The Registrar (July 2) A second assistant in zoology in the University of Aberdeen — The Secretary (July 8). An assistant in pathology in the University of Aberdeen—The Secretary (July 8) An assistant in the Nautical Almanac Office — The Secretary, Civil Service Commission, Burlington Gardens, W 1 (July 9). A demonstrator in chemistry in the University of Aberdeen—The Secretary (August 8). A lecturer in education in the University of Manchester — The Internal Registrar An assistant in the department of geology of the Queen's University of Belfast—The Secretary A lecturer in biology with special qualifications in zoology, and a lecturer in chemistry, at the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth.

Research Items.

THE SAN BLAS INDIANS.—Recent references to the San Blas Indians of Panama in connexion with the occurrence of "White Indians" in Darien, and their uprising against the control of the Panama Government a month or two ago, give a topical interest to an article on these tribes by Mr. A. F. Loomis in *Scribner's Magazine* for June. They now number about 30,000. Those who live on the coast are skilled sailors, their canoes, logs hollowed by elementary tools without keel or deck, going out to sea when the weather is too rough even for coasting schooners. Little is known of them, no one not of their race is allowed to remain within their territory at night. The women wear gold nose-rings, but the most characteristic feature of their dress is an upper garment of appliqué work which is made of pieces of coloured material sewn on to a cloth foundation in most intricate and highly conventionalised patterns. Large flat discs of beaten gold are worn pendent from the ears. Armlets and anklets of beads are wrapped so tight as to stunt the extremities. The marriage ceremony consists in carrying the groom to the girl's house and placing him in her hammock, whence he flies for two nights in succession. On the third night he lifts her veil and sees her face for the first time. The next morning he leaves his father's house, and the eating of the meal the bride has prepared concludes the marriage rite. The son-in-law resides with the bride's father and virtually becomes his servant.

EXCAVATIONS AT MARGIDUNUM.—In describing pottery from a well of Claudian age at Margidunum (Notts) in the Journal of the Society for the Promotion of Roman Studies, vol. 13, pts. 1-2, Dr. Felix Oswald gives a brief account of the general results of his excavations, which have extended over several years. This camp formed a link in the chain of frontier posts established between Severn and Trent in A.D. 47. Previously it was unknown except by name. The site covers about 8 acres. The mud surface due to marshy ground was cleared away by the Romans and about six inches of river sand substituted. Drainage ditches flowing into the first of five outer ditches have furnished some of the earliest evidences of Claudian occupation in the pottery, which often shows La Tène features, Claudian sigillata ware, a coin of A.D. 41, and a tinned bow brooch almost identical with a tinned fibula from Ham Hill, Dorset, which has been dated A.D. 40-50. The persistence of La Tène features in the pottery suggests that local native industries were not suppressed but rather that there was an increased demand. Under Nero and Vespasian iron was smelted in rectangular pits with side gulleys exactly as in Africa to-day. The fort was twice destroyed by fire, possibly by Boudicca and by the Brigantes, and was abandoned before the end of the first century.

A NEW BRITISH LAND PLANARIAN.—Mr. E. Percival records (*Quart. Journ. Micr. Science*, March 1925) the finding of a new British land planarian—*Rhynchodemus britannicus*. He collected specimens in Yorkshire under large stones and logs which had lain undisturbed for a considerable time, always on moist clay or loam, and associated with earthworms and slugs, never with centipedes and carnivorous beetles. The planarian, which is extremely contractile, may attain a length of 90 mm., and is 1·5 mm. broad when in the extended condition. The anterior end tapers gently to a fine point, and just behind the tip is a single pair of minute eyes. The colour is variable—sulphur-yellow, salmon-pink, or dirty grey, and the ventral surface is paler, the mid-ventral region being practically white. The mouth is mid-ventral and about the middle of the length of the worm, and the genital pore 5-8 mm. farther back. Mr. Percival gives a brief account of the anatomy, which is similar to that of other species of Rhynchodemus. The cocoons are 2 to 3 mm. in diameter. The planarian feeds on earthworms, sucking up the partly decomposed tissues of the worm and leaving only the cuticle, but how the worms were killed could not be ascertained. In one specimen many spores of a gregarine, probably Monocystis, were present in the endoderm cells, no doubt ingested while feeding on an earthworm. Two examples of this new species have also been collected at Stockport, and the author thinks that a specimen found at Plymouth probably also belonged to this species, in which case this new planarian would appear to be widely distributed in England.

THE DEVELOPMENT OF EGG FRAGMENTS.—Prof. C. V. Taylor and Prof. D. H. Tennent give a preliminary report (Carnegie Institution of Washington, Year Book 23) on the development of fragments of the egg of the sea urchin *Lytechinus* (*Toxopneustes*) *variegatus*, which they studied in the Tortugas Laboratory. The methods of micro-dissection were employed, *i.e.* the eggs were cut with very fine glass needles manipulated in a moist chamber on the stage of the microscope under fairly high magnification. A preliminary experiment was carried out to ascertain whether the operative technique would cause the parthenogenetic development of the egg, 50 eggs were pricked with the tip of the micro-needle but none developed. Eggs were transected in the vertical or the horizontal plane into two halves, one nucleated and the other not. When these halves, transferred to watch glasses, had rounded off, sperms were added, and by careful treatment many fragments both nucleated and non-nucleated were reared to the pluteus stage. 122 pairs of such fragments were studied. Cleavage followed insemination in 74 of the nucleated fragments and in 66 non-nucleated portions. The cleavage of both fragments is not, as stated by Delage, identical and as in the normal egg—one of the fragments follows the normal mode, but in the other the cleavage which should have given rise to the micromeres was an equal division of the cells of the vegetative half, and this division occurred shortly after the equal division of the four cells of the animal half of the fragment.

BIRDS AND BUTTERFLIES OF EAST AFRICA.—The Journal of the East Africa and Uganda Natural History Society takes a high place among publications devoted to the description and bionomics of local fauna. A recent issue (No. 21, March), under the editorship of Dr. V. G. L. van Someren, contains the opening parts of two excellent faunistic papers, dealing respectively with the birds and butterflies of Kenya and Uganda. The former of these papers, which is the work of the editor, gives a good account of the Guinea-fowls of the region, and is illustrated by a plate representing seven of the species, together with a diagram explaining the nomenclature of the external parts of a bird, and a chart showing the elevations from the lake level to the coast at Mombasa, with the various avifaunal areas. Careful descriptions are given of the adult and the successive immature stages of the plumage in each species, and valuable notes are appended on the distribution, courtship, nesting, and feeding habits of this characteristically African group of game-birds. The following paper, on the butterflies of the same region, is the joint work of Canon K. St. A. Rogers and Dr. van Someren. The

species dealt with are those of the genera Danaida and Amauris. An admirable series of photographs accompanies the paper, in which are depicted numerous examples of the eggs, larvæ, and perfect insects of many of the forms described. As in all the work of Canon Rogers, great attention is paid to points of bionomic interest, and we may be permitted to trace in his careful notes on distribution, mode of flight, relative distastefulness, mimicry, etc., the influence of the Hope Department at Oxford, the studies pursued in which place owe so much to the activity and perseverance of Canon Rogers as a collector. It is to be hoped that these contributions to the natural history of East Africa, so well begun, may be pressed to an equally valuable conclusion.

VIRUS DISEASES OF THE HOP.—E. S. Salmon and W. M. Ware briefly describe two virus diseases of the hop, "nettle head" and mosaic, in the *Gardener's Chronicle* for May 9. In connexion with the interesting work they are doing at Wye in raising new strains of hop of commercial promise, the authors had occasion to send out a new seedling for trial in the hop-gardens. This seedling, while itself apparently resistant to mosaic, has thus come under suspicion as a carrier of mosaic to the susceptible varieties around it, thus recalling Bewley's experience with tomato plants and the similar suggestion made by Atanasoff (*Phytopathology*, March 1925) that the potato varieties Ashleaf and Koksiaan (equivalent to Jersey Non Such), themselves very resistant to stipple-streak, may transmit it to varieties, which are then swept away by its ravages. Only experiment can settle such questions, and as virus diseases are most certainly transmitted by grafting, Salmon and Ware describe successful methods for grafting hops.

RHODODENDRONS FROM KWEICHOU, CHINA.—Twelve more flowering plants are figured in the plates in Part III. of Volume 150 of *Curtis's Botanical Magazine*; they range from an old-established horticultural favourite like *Begonia manicata* Linn., introduced from Mexico before 1840, to a cultivated cypress drawn from the temple groves of Yunnan, China, *C. Duclouxiana* Hickel. A rhododendron from the Chinese province of Kweichou, *R. Lyi* Léveillé, provides the occasion for a very interesting discussion by the editor, Dr. Otto Stapf, of the limestone area in this province, studied first by the French missionaries and later also described by Sir Alexander Hosie in his book "On the Trail of Opium." Kweichou has the reputation of being one of the deforested provinces of China, but in this dry limestone plateau, with peaks climbing to more than 2000 m., with a temperate climate save in the deeply cut valleys where it is subtropical, rhododendrons are described as growing in profusion. The limestone is said to be triassic in character. It will be interesting to learn whether the rhododendrons gathered from this area prove tolerant of limestone soils in Great Britain.

RATOON COTTON.—Some observations upon the fibre obtained from ratooned cotton plants in Queensland were mentioned recently in these columns (NATURE, January 31, p. 171). James Templeton, botanist to the Ministry of Agriculture, Egypt, in Bulletin No. 55 of the Technical and Scientific Service of the Ministry, discusses the causes which have led to the disappearance of ratooned cotton from the Egyptian supply. Templeton points out that after its introduction in 1921, cotton was usually grown as a perennial crop, and that the change to cultivation as an annual may be traced to a practice prevailing upon the better lands when the cultivators were compelled by Mohammed Aly to grow the plant, although then a relatively unprofitable crop. The perennial method of cultivation still persisted over large areas, until prohibited by the Government in 1912 as part of a campaign against insect pests thought to be harboured over winter by the standing crop. Templeton finds no evidence that the cultivation of the plant as a perennial was given up because ratooned cotton proved to be of inferior quality. As the result now of actual experiment he records with Sakellarides an increased yield of lint in the second year with quality probably not inferior. Furthermore, in the second year, the loss from boll-worm attack has not been so great as in the first year.

EXTINCT ELEPHANTS IN ENGLAND.—The elucidation of the inter-relationship of the many forms of Pleistocene elephants is a most difficult problem, especially when it is remembered how fragmentary the evidence is. A valuable paper has recently been published by Dr. Sandford in the Quarterly Journal of the Geological Society, vol. 81, No. 321, on "The Fossil Elephants of the Upper Thames Basin." This paper, together with one on "The River Gravels of the Oxford District" in the same journal for 1924, form an opening attack by Dr. Sandford on the general problem of the evolution of the elephants of the period. The author finds *E. antiquus* of an archaic type in the Handborough Terrace Level and in the Wolvercote Channel, a later level, specimens of a smaller form of the species which appear to be akin to the small form found at Barrington and in the Forest Bed. *Elephas primigenius* occurs in the Summertown-Radley Terrace and *E. antiquus* is again found in a level overlying this, which points to a warm phase following a colder one.

TIDES AND CURRENTS IN NEW YORK HARBOUR.—Under this title the U.S. Coast and Geodetic Survey has recently published a connected account by H. A. Marmer of the chief movements of the various tidal waters in the neighbourhood of New York. Observations at a large number of stations both on shore and off shore have been taken at various times, partly by the Survey itself and partly by the U.S. Engineer Office, and these afford material for a descriptive account which is exceptional in its completeness. An idea of this completeness may be gathered from the fact that the pamphlet contains 70 tables and 52 diagrams. Fort Hamilton, which occupies a central position in the region considered, is chosen as the standard station, and the characteristics of the tidal elevation at this place are summarised in 48 non-harmonic constants. Harmonic constants are given for the currents at Scotland Light Vessel, Ambrose Channel Light Vessel, and the Narrows, the results for each of the first two of these stations being based on hourly observations extending over 87 days. In several instances the elevation-gradients transverse to the current are connected with the currents and the earth's rotation in close agreement with dynamical theory. The currents in East River turn about half an hour after the waters at its two ends reach the same level, while the non-periodic flow from the Hudson River decreases in strength from the surface downwards. The monograph closes with a set of 13 maps, showing the states of the tide and current for each hour relative to the time of high water at Fort Hamilton. The pamphlet is well written and shows a regard for precision which is very welcome.

MEASUREMENT OF ATMOSPHERIC HUMIDITY.—Hygrometric tables have been prepared by the Meteorological Office, Air Ministry, for the computation of relative humidity, vapour pressure, and dew point from readings of dry and wet bulb thermometers

exposed in Stevenson screens (H.M.S.O., 1s. 6d. net). The tables have been brought into use for obtaining data for publication from the commencement of the current year. Hitherto the tables in use in Great Britain were based on constants known as Glaisher's factors, said to be drawn up on an empirical formula. The new tables have been freshly computed on the basis of Regnault's formula and may be taken as practically identical with similar tables prepared by the Austrian Meteorological Service—with a light air blowing. They are not suitable for factories or store-rooms, unless precautions are taken to secure adequate motion of the air. The tables are, strictly, more scientific than those hitherto used in England and are in agreement with the best in use in other countries. Formulæ are given so that in countries where temperatures are common outside the scope of the tables, it is recommended to expand the table by computing other values. The preface by Dr. G. C. Simpson, the Director of the Meteorological Office, states that the results given by Glaisher's tables are in practical agreement with those obtained from the most recent tables based on Regnault's formula. Hygrometric tables based on Glaisher's factors were expanded and issued for private circulation by the Meteorological Office nearly half a century ago, and it is a satisfaction to know that the results used for so many years differ so slightly from the results which are the best obtainable to-day. The tables are very concise.

VAPOUR PRESSURES OF FUEL MIXTURES.—Considerable attention has in recent years been devoted to the problems of vapour pressure of those liquids or liquid mixtures used as fuels in internal combustion engines. Such matters as loss incurred on handling or storing fuel, internal pressures developed in tanks or other containers used for transporting fuel, fire risk, and the facility with which fuel is vaporised in carburettors all depend on the vapour pressure of the liquid at or just above ordinary temperatures. Mr. J. Stanley Lewis discussed this subject recently at the Institution of Petroleum Technologists, and gave the results of several careful vapour-pressure determinations on binary and ternary mixtures. Starting with hexane and benzene, he showed that there is a rise in vapour pressure caused by traces of water, and that calcium chloride as a desiccant is inefficient. The author employed phosphorus pentoxide more satisfactorily in this connexion. He next gave results of vapour-pressure determinations on fractions of petrol and mixtures of the fractions, on mixtures of benzene with hexane and cyclohexane, and on motor benzol with No. 1 and No. 3 petrol. Other mixtures investigated include benzene and alcohol, ethyl alcohol and No. 1 petrol, ethyl alcohol and No. 2 petrol, and alcohol and water. An example of a ternary mixture is given by the fuel benzol and alcohol plus the small amount of water existent in commercial alcohol, while a petrol-alcohol-water mixture constitutes a similar case. Briefly stated, the addition of one component to a mixture of the other two raises the vapour pressure, and for a given concentration of a ternary mixture there will be a fourth (highest) maximum vapour pressure. In binary fuel mixtures, where the two components are completely immiscible, the vapour pressure of the mixture is the sum of their partial vapour pressures, where there is partial or complete miscibility the vapour pressures vary according to the degree of concentration of the components, and may lie between or be higher or lower than that of either component.

FATIGUE STRENGTH OF STEELS.—Messrs. Aitchison and Johnson presented the results of an investigation on "The Effect of Grain upon the Fatigue Strength of Steels" at the May meeting of the Iron and Steel Institute. This work was carried out on behalf of the Engineering Research Board of the Department of Scientific and Industrial Research, which made a grant towards its cost. The test results have been obtained by examining a complete series of specimens, commencing with a large steel cast ingot, followed by specimens at different stages of forging, the final specimen representing a reduction in cross-sectional area of 96 per cent. of the original casting. In addition, tests were made upon commercial mild steels, high quality nickel chromium steel, Staffordshire wrought irons, and Armco iron. The report deals mainly with the mechanical properties, particularly the fatigue strength of steels when tested parallel to and at right angles to the direction of elongation during forging. The authors find that the direction of the grain has a marked influence upon the ductility recorded in the tensile test, and upon the toughness as measured by the impact test. The maximum stress of the material is not appreciably different in the two directions, nor is there such a large difference in the fatigue strength as had been anticipated. The authors always found that the values of this property were higher in specimens cut parallel to the direction of forging than in those cut at right angles. The maximum difference found is 16-17 per cent.

LITHIUM SOLUTIONS IN LIQUID AMMONIA.—C. A. Kraus and W. C. Johnson have recently measured the vapour pressures of solutions of lithium in liquid ammonia. The results, published in the March issue of the Journal of the American Chemical Society, afford no evidence of the existence of compounds of the alkali metals with ammonia of the nature of ammonium groups. The saturated solution contains 3·61 molecules of ammonia per atom of lithium.

MAGNETIC PROPERTIES OF SILVER HALIDES.—Recent work by A. Garrison, recorded in the March issue of the Journal of the American Chemical Society, shows that silver chloride is diamagnetic and becomes less so on illumination, whereas the bromide and iodide are slightly paramagnetic and become more so on exposure to light. These changes on illumination are instantaneous. It is pointed out that a change in the magnetic permeability would naturally accompany an increase in electrical polarity, an occurrence which is suggested by the fact that the absorption of light causes the halides to be more soluble in water and better conductors of electricity.

SOAP SOLUTIONS.—An interesting paper by J. W. McBain and G. M. Langdon on the equilibria underlying the soap-boiling processes appears in the Journal of the Chemical Society for April. The investigation consisted in the examination of the sodium palmitate—sodium chloride—water system, and phase rule diagrams are given for a series of temperatures. In any soap system the following phases can exist: lamellar crystals, crystalline curd fibres, anisotropic liquid "neat soap," anisotropic liquid "middle soap," and isotropic liquid. Soap-boiling operations depend on the equilibria between these phases. "Neat soap," "middle soap," and "isotropic solution" are three forms of soap solution proper; the first two are anisotropic (doubly refracting). Isotropic liquid solutions of sodium palmitate form a phase which includes wholly colloidal and wholly crystalloidal solutions within the temperature range investigated. Pure water and pure anhydrous liquid sodium palmitate are miscible in all proportions above 316°. The contents of the commercial soap pan behave approximately as a simple three component system, apart from crystallisation.

The South-Eastern Union of Scientific Societies.

ANNUAL CONGRESS AT FOLKESTONE.

THE thirtieth annual congress of the South-Eastern Union of Scientific Societies was held at Folkestone on June 3-6 inclusive At the opening meeting and before leaving the chair after his year of office, Sir Richard Gregory presented in the name of the Union an illuminated address to Mr H Norman Gray, former secretary to the Union Sir John Russell, director of Rothamsted Experimental Station, then assumed the presidential chair, and delivered his address on "The Place of Science in Rural Life" He traced the changes in the manner of manuring since the empirical days of the ancients, citing as an instance the twelfth-century writer, Idn-el-Awam, who said that human blood stimulated decomposition of manure-heaps and gave a valuable fertiliser Science was first introduced into rural life when in 1834 Boussingault began analysing his crops and manures In comparing the output per man on a Sussex farm it was stated that in 1881 it took 117 man-hours to grow one ton of wheat, but only 82 in 1921. "A clod of earth is a storehouse of wonders which are being patiently explored in the experimental stations and colleges"

In the Botanical Section Mr A G Tansley, F R S, drew a large audience to hear a paper on "The Vegetation of the Southern English Chalk" He explained the various ecological factors of the chalk, and touched upon plant communities, the pioneer vegetation, the chalk grassland, the chalk scrub, the chalk woodlands, beech forest, the succession of vegetation on the chalk, and the factors arresting the succession in various stages

In the Geological Section Mr A G Davies directed attention to the many sections that are being temporarily exposed in the progress of excavations for new arterial roads Mr Davies has done a good deal of work around London, and in particular dealt with the widening of the main Brighton road at and about Merstham, and cuttings and borings between that point and London, the latter part being examined in detail in the boring of the Tube from London to Merton, the strata covering from the base of the Chalk to the top of the London Clay An interesting and fruitful section at Woodfield Hill showed an exposure of 400 yards in the *Holaster planus* zone, with a continuous section of the Chalk Rock or Reussianum band, perhaps one of the finest sections of Chalk Rock in Britain. Much new palæontological work has been done on the section. From the Clapham Road portion of the Tube in the London Clay the "sea-serpent" of Owen, *Ophida toliapicus*, was rediscovered after the lapse of nearly a century.

Mr D Ward Cutler made a valuable contribution in his paper on "Life in a Garden Soil" There is a vast assembly of little-known creatures in a piece of garden soil It had long been suspected that in sewage beds the conversion of ammonia into nitrate was not a chemical but a biological process, but not until 1880 was it shown that the process involved two stages, associated with two organisms, and the organisms were isolated in artificial culture All decomposition and purification of the soil is now known to be due largely to the activities of bacteria

The Regional Survey Section listened with interest to Mr Geo L Pepler on "Surveys as Preliminaries to Town Planning," and in the Zoological Section Mr E C Stuart Baker gave a brilliant address on "Field Naturalists and Evolution," to illustrate which he brought many cuckoos' eggs from his collection, showing gradations in size and markings between the eggs of the foster parent and those of the cuckoo from decided diversity to perfect resemblance

In pursuance of the custom of recent years of bringing to notice the uses of the cinema for educational purposes, a lecture was arranged at the Picture Theatre, at which some hundreds of children were present, when Dr Clarence Tierney lectured to them on "Some of Nature's Secrets" Mr E A Martin raised some controversial points in his paper on "Some Controversial Points in Anthropology" He suggested that the differences of opinion as to the age of the human jaw discovered in Kent's Cavern should be adjudicated upon by a committee of experts In dealing with the pictorial representations of the human form on palæolithic cave-walls, he made the suggestion that we may have here preserved what were really monstrous forms of the human race, when the species was scarcely fixed and the race was still in a plastic condition

Many interesting excursions were made, amongst them being one to what has been called the finest Roman site in the south-eastern counties, and another to Dungeness point, rendered famous of late years on account of the supply of fresh water which is to be found within three or four feet of the gravel surface.

The Calculation of World Temperatures.

MATHEMATICAL expressions giving the variation of air temperature with such factors as time and latitude have been obtained by a number of different meteorologists by evaluating the several coefficients in a Fourier series. Mostly the investigations have been confined to conditions existing in a particular locality, and in only a minority of cases have world conditions been considered. When only one locality is considered, the task is comparatively straightforward. If, however, the whole world is dealt with, the accuracy of the results will be limited by the number of observing stations existing over the earth, and more particularly by their distribution. To obtain satisfactory mathematical relations a series of observations extending over a considerable number of years is necessary. Over the more densely populated parts of the earth it is usually possible to make a selection of stations which shall be fairly representative of the whole area, but over many large areas no information exists at all. Over other large areas the observing stations are very sparsely distributed, and to obtain results which are true on the average for the whole area is correspondingly more difficult.

The author in the publication before us[1] has dealt first with the simpler case, taking Brussels as the locality to be considered, and afterwards he has extended the investigation to cover the whole globe. This very considerable task was undertaken during the War, when night astronomical observations at the Royal Observatory of Belgium were forbidden by the German military authorities.

The maximum, minimum, and mean temperatures for Uccle extending over a period of 75 years have been extracted from *L'Annuaire Météorologique* for 1908 and used to establish general mathematical expressions which will give for any date in the year the

1 "Expression analytique des variations de la température de l'air." Par H. Philippot. Pp. 48. (Bruxelles: M. Hayez, 1924). 5 francs.

mean temperature, mean maximum, mean minimum, absolute maximum, and absolute minimum temperatures. The values of each of the five elements for every day in the year are stated in tabular form.

In extending the relations to different parts of the globe, recourse has been made to Hann's "Lehrbuch der Meteorologie" for information relating to 143 stations, coastal and inland, scattered over the two hemispheres, and the results for Brussels and Nertchinsk are added to these Expressions have been obtained for the same five temperature means and extremes for all of these stations, while for 26 of them more exact expressions have been calculated. The accuracy of these latter expressions may be gauged when it is stated that the difference between the observed and calculated monthly mean temperatures in no case amounts to 1° C, and in most cases is a small fraction of this amount.

To progress from the results for individual stations, the earth's surface is divided into belts of 10° of latitude For each belt the mean latitude is obtained for the stations contained in the belt and also the mean of their respective temperatures The results obtained for the successive belts are then integrated to obtain a mean temperature for the whole globe and for each hemisphere The values obtained are (1) for the whole globe, 15°·61 C, (2) for the northern hemisphere, 16° 15 C; and (3) for the southern hemisphere, 15°·07 C These results are somewhat higher than those given by Angot in his "Traité de météorologie" This may to a certain extent be accounted for by the fact that no allowance has been made by the author for the relative amounts of land and water in his successive belts of 10° of latitude, as was done by Spitaler and Forbes in their calculations. The difference between the observed mean temperature at any place and the value calculated for that latitude gives a measure of the effects of topography and local conditions, such as nearness to the sea, the direction of prevailing winds, the influence of ocean currents, etc. These effects of continentality and oceanity have further been considered as equivalent to a change of latitude, and examples are given for different places the mean temperature of which is equal to that for latitudes considerably nearer the equator or the poles.

The amplitude of the temperature oscillations has been similarly considered, because this is also dependent upon latitude, and the difference between the observed and the calculated amplitude will again be due to local conditions, the climate being more or less equable than is general for the latitude. The effects of continentality and oceanity on both mean temperature and its amplitude are shown on charts.

A possible allocation of dates is suggested for the meteorological seasons based on temperature changes The dates for the change of seasons would be those where the maximum, minimum, and mean temperatures were passed To a first approximation for places outside the torrid zone, the dates obtained (January 22, April 24, July 24, and October 23) are about one month later than the corresponding astronomical seasons

The author concludes that the really determining factor in temperature is latitude, and that the other conditions, topographical or local, give rise only to more or less important perturbations the effects of which can be obtained by direct observation alone R S R.

Botanical Exploration in China.

THE *Anzeiger* of the Vienna Academy of Sciences for 1924, which has recently been issued, contains, among other interesting matter, parts 25-30 of Dr. H Handel-Mazzetti's "Plantae Novae Sinenses" They add another century of new species and varieties of Chinese plants to those included in the earlier numbers There is no definite plan in the selection of the plants described as new The descriptions are rather in the nature of gleanings obtained in the course of the author's elaboration of the extensive material which he collected during his five years' exploration work in China, and of preliminaries towards a full account of his expedition This, we understand, is almost ready for the press, and as Dr Handel-Mazzetti is not only a highly competent botanist and an experienced traveller—he has done good work in Kurdistan and Upper Mesopotamia—but also a naturalist with a very comprehensive and thorough training, we are eagerly looking forward to its publication

Dr Handel-Mazzetti went to China with Camillo Schneider, the well-known dendrologist, early in 1914 on behalf of the Austrian Dendrological Society and with the support of the Vienna Academy of Sciences, the immediate object of the expedition being the Upper Yangtse basin between 27° and 30° N The travellers left Yunnan fu in March 1914 and devoted themselves during the spring and early summer to the exploration of the Yalung basin in southern Szechuan and of the north-western corner of Yunnan. When Schneider left in July for America, Handel-Mazzetti continued the work alone. He returned to Szechuan in the autumn, going afterwards to Mengtse and Manhao on the Red River and, in the spring of 1915, to Yunnan-fu, whence he started for the Likiang range, crossed the Mekong, and penetrated to the watershed of the Salween and the Kiukiang, the easternmost tributary of the Irawadi. The next year was given up to the exploration of the Upper Salween basin as far as its western and northern boundaries. After having spent the winter of 1916–1917 at Yunnan-fu, Handel-Mazzetti turned his attention to the botanically very incompletely known provinces of Kweichou and Hunan He traversed southern Kweichou from west to east and reached Changsha in Hunan towards the end of 1917. The following summer saw the explorer in Central and South-West Hunan After another winter in Changsha, which was spent in preparing his extensive collections for despatch to Europe, Handel-Mazzetti left China, arriving in Vienna in the early summer of 1919

Dr. Handel-Mazzetti published preliminary accounts of the floral zones and plant-formations of West Szechuan and Yunnan in the *Anzeiger* in 1916, 1917, and 1920, and a revised account in Engler's "Botanische Jahrbücher," Band 56, with a map (1921), whilst a similar account dealing with the flora of Kweichou and Hunan appeared in the *Sitzungsberichte* of the Vienna Academy in 1919. A preliminary report on his exploration in Yunnan may be found in the *Mitteilungen* of the Geographical Society of Vienna in 1919 and a paper "Ergebnisse der Expedition Dr Handel-Mazzetti's nach China, 1914–1918. Neue Aufnahmen in N.W. Yunnan und S. Setschuan," accompanied by a map, in the *Denkschriften* of the Vienna Academy in 1921. The latter contains important contributions to the glacial geology of the country and is repeatedly referred to in J. W. and C. J. Gregory's recent memoir on "The Geology and Physical Geography of Chinese Tibet" (Phil. Trans. Roy. Soc., London, Ser. B., Vol. 213). Dr. Handel-Mazzetti, who is an excellent photographer, has also made a fine collection of slides (partly coloured), many of which are of great beauty. O. S.

University and Educational Intelligence.

CAMBRIDGE.—The Council of the Senate has nominated Mr Ernest Harrison, senior tutor of Trinity College, for the post of Registrary of the University, on the resignation of Dr J N Keynes

The special Board of Biology and Geology has nominated P R Cuvati, to use the University Table at Naples

An annual grant of fifty guineas is to be made from the University to the Marine Biological Station at Plymouth

The honorary degree of Doctor of Science has been conferred on Prof J Joly, professor of geology and mineralogy in the University of Dublin, and on Dr. A P Maudslay, distinguished for his contributions to the archæology of Central America and Yucatan

DURHAM.—Dr Thomas Alty, lecturer in physics, has accepted an invitation to a chair of physics in the University of Saskatchewan Dr. Alty was Oliver Lodge fellow and prizeman of the University of Liverpool in 1921, and while at Trinity College, Cambridge, he worked with Sir J J Thomson at problems of bubble-surfaces, this research he has developed while in his post at Durham

Three further lectureships have been established in the departments of applied mathematics, geology, and botany, these have been filled respectively by Mr E F Baxter, assistant lecturer in mathematics at the University of Sheffield, Mr William Hopkins, research student of Armstrong College, Newcastle; and Miss Elsie Phillips, Isaac Roberts scholar and demonstrator in botany at the University of Liverpool The report of the Department of Pure Science at Durham shows that during this, its first session, ten papers on original work will have appeared and that the entry-list for 1925-6 is full

LEEDS.—On the nomination of the Senate, Prof J W Cobb has been elected Pro-Vice-Chancellor of the University in succession to Prof Jamieson, whose term of office expires at the end of this month. The Council has agreed to co-operate with the City Council in extending an invitation to the British Association to hold its annual meeting in 1927 at Leeds

LIVERPOOL.—The honorary degree of D Sc has been conferred on Sir J C Irvine, Principal and Vice-Chancellor of the University of St Andrews, and the honorary degree of D Eng on Sir Dugald Clerk, formerly Director of Engineering Research at the Admiralty, the distinguished authority on gas and oil engines.

LONDON.—Miss Helene Reynard has been appointed Warden of the Household and Social Science Department, King's College for Women Miss Reynard, who was for some years resident junior bursar of Girton College and is now treasurer and secretary of Somerville College, will take up her new duties early in October

MANCHESTER.—The following appointments in the Faculty of Technology have been made Dr T K. Walker to be lecturer in applied chemistry; and Miss Marion Chadwick and Mr. A. Hancock to be assistant-lecturers in applied chemistry.

OXFORD.—The annual report of the Delegates of the University Museum, lately published, contains a detailed account of the teaching given and the researches performed in the various scientific departments of the University, together with a notice of the additions made during the past year to the Museum collections These, in several of the departments, have been both numerous and interesting The list of accessions to the Pitt-Rivers museum covers five large quarto pages

Preparations for the visit of the British Association in 1926 are in active progress Some of the committees have already met, and an office has been secured for the local secretaries

The Boyle Lecture, delivered by Prof J Joly dealt with the geological age of the earth, estimated by the carrying of salt into the sea by rivers, and by the radioactive decay of thorium and uranium The results of these different methods were shown to be fairly accordant

In the Halley Lecture, delivered on June 17, Dr W W. Campbell, President of the University of California and Director of the Lick Observatory, discussed the position and constitution of the star-group to which the solar system belongs, in relation to the stellar universe

The members of the Universities Commission are nearing the end of their labours The Statutes of all or most of the Colleges have now undergone their final revision.

MR BERNHARD BARON, of Brighton, has given a sum of 10,000*l* to the Jewish University in Jerusalem.

SINCE the Imperial College of Science and Technology, South Kensington, was founded by Royal Charter in 1907, questions of its relationship to the University of London have been under discussion The College includes as integral parts the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College, and it possesses the fullest equipment for the most advanced training and research in various branches of science Unlike University College and King's College, it is not incorporated in the University of London, though for the purpose of internal degrees of the University it was admitted as a school of the University in the Faculties of Science and Engineering in 1908 The courses of work at the College do not, however, follow the University syllabuses, being distinctive from them both as regards method and content In spite of this, many of the students take science degrees in the University in addition to their College diplomas, indeed, the diploma courses are of equal standard to those required for honours degrees at the University The duplication of effort and examination thus involved will in future be avoided through a scheme which has been accepted by the governing body of the College and the University senate for the conduct of final B Sc (Special) and B Sc (Eng.) examinations for students of the College The University has adopted the College examinations as its own and will appoint the internal examiners of the College to be its own examiners while it will, in addition, appoint its own external examiners The scheme is a simple, business-like arrangement that might be made between any first-class college and any recognised university, but it really represents a very big step in principle, and marks the beginning of an entirely new era in university education. It means that the Imperial College retains its individuality in methods of training while the University examinations are subordinated to the teaching instead of, as hitherto, the teaching being controlled by the examinations For this satisfactory solution of a long-standing problem Sir Thomas Holland, Rector of the Imperial College, is largely responsible, and we congratulate both the College and the University upon the friendly spirit in which the scheme now established has been discussed and secured

Early Science at Oxford.

June 24, 1684 Mr Musgrave further informed the Society that if ye Jugular veins in men communicate one with ye other, in ye same manner, as they did in his Dog, we may then argue hence, that bleeding in ye jugulars, is more proper in some distempers of ye head, than severall physitians (who suppose no considerable communication between ye brain, and externall jugulars) will allow.

It was ordered, that ye Eclipse of ye Sun, on ye 2nd of July next, be strictly observed, and that all things necessary for that purpose be made ready by that day

Mr Walker mentioned a Barometer he has, ye tube of which, at about 27 inches from ye open end, turnes in an obtuse angle, for ye better observing ye ascent of ye quicksilver He was desired to shew it ye Society at ye next meeting

June 26, 1688. The thanks of the Society are returned to Mr. President, for a letter communicated by him from Mr Hillyer, being a farther account of customs and religion of ye Indians

In consideration of the great pains and trouble Dr Wallis has been at in the care of printing *Aristarchus*, the Society give order that their thanks be returned to the Doctor

Ordered that an *Aristarchus* be sent to Dr Garden, one to Dr. Middleton To the Vniversitys of Aberdeen, and Glascow, Edinborough and St Andrews To Mr Molineux, and the Provost and Library of Dublin To Mr Ash To Mr Jessop To Dr Lister To the Secretarys of the Royall Society, and the Library of the Society, and the President of the Royal Society To Dr. Chamberlain To Mr Flamstead To Dr Pitt. To the Vice-chancellor and Publick Library. To Mr. Halley Ordered that Mr Charlet deliver one from the Society to Mr. President

The Tutenage of Japan was shewed to the Society, being used for paper to wrap up goods, or make sacks: Of the same sort being thicker are made the tea-pots It is a metall finer than lead or tin, but neither the one nor the other The thanks are returned to Dr Hide for his communication of the heads of some Japan matters he has communicated to ye Society.

June 29, 1686. Mr Caswell communicated part of a letter from Mr Halley, wherein he acquaints him that he intends to try some experiments concerning the specific gravity of the air A discourse of Dr Lister's read, concerning the improvement of *Agriculture*

July 1, 1684. Mr Walker presented his Barometer, mentioned in ye Minutes of ye præceding week, to ye Society, ye tube of it, at ye distance of (about) 27 inches from ye upper end, was bent, in an angle of 108 degrees, for ye better observing ye motion of ye quicksilver, which, in ye sloaping part of this tube, does rise, and fall, 2½ inches, for one inch in a tube exactly perpendicular

Mr Bernard was pleased to acquaint ye Society, that a spot in ye Sun was seen by Mr Caswell on Thursday last, and by himself at ½ hour after 7 in ye morning, at which time it was not far from ye rim of ye Sun: it appeared to be a thick firm spot, and to take ye same course, with that observed, not long since, by Mr. Flamsteed, (*vid.* Minutes of May 27, 1684,) for it passed over near ye center of ye Sun. He tells us farther, that he looked after it again on ye Monday following but could not see it; it had made its exit. We are promisd a more full account of this matter

Dr Bathurst informed ye Society, of a relation he lately received out Somersetshire, concerning ye great damage done to ye beans in that county, by vast numbers of caterpillars.

Societies and Academies.

LONDON.

Royal Society, June 18.—Lord **Rayleigh**: Luminous vapour from the mercury arc and the progressive changes in its spectrum. This investigation deals with the luminous stream of vapour observed when mercury distils away from the arc *in vacuo*. The lines of the arc forming known spectrum series are for the most part strongly developed in the vapour stream An exception is line 1850 $1P$—$1S$, which is strong in arc, but inconspicuous in vapour Higher members of various series appear in greater relative intensity in vapour than in the arc. The continuous spectrum of mercury, not noticeable when the vapour first emerges, becomes more conspicuous as the vapour matures. In the limit the spectrum tends to consist simply of line 2537 and continuous spectrum If the vapour is passed through a metal tube maintained at negative potential, the luminosity of the line spectrum in general tapers down to a sharp point, beyond which it disappears. Line 2537 behaves differently Much of its light tapers down to a point which, however, is beyond the place where the other lines are extinguished, but a residuum is of a different origin and does not admit of extinction. The light of the band spectrum also passes on.—J C **McLennan** and G. M **Shrum**. On the origin of the auroral green line 5577 Å and other spectra associated with the aurora borealis. In studying the effect of large admixtures of helium on the spectrum of oxygen, a hitherto unknown line has been photographed The wave-length of this line has been found to be $5577{\cdot}35 + 0{\cdot}15$ Å It is very sharp and is subject to great fluctuations in intensity. Evidence has been produced to prove that this line is identical with the auroral green line $\lambda = 5577{\cdot}350 + 0{\cdot}005$ A This line must be attributed to some hitherto unknown spectrum of oxygen, and it is not a limiting member of the ordinary band spectrum of oxygen. Helium has been used to bring out the bands of nitrogen, with an intensity distribution similar to that found in the aurora. The possibility of metastable helium acting as the exciting agent in the auroral spectrum has been discussed.—J. C. **McLennan** and A B. **McLay**: On the series spectrum of gold. Absorption spectra of the vapours of gold, silver and copper in the Schumann region have been investigated. The second members of principal series of doublets in the gold arc spectrum are $\lambda = 1646{\cdot}71$ (I vac.) and $\lambda = 1665{\cdot}75$ (I vac.). Similarity exists between the term systems gold I, copper I, and zinc II, in respect of their inverted s terms, and the term systems of gold I and copper I in respect to certain special π terms. The term systems silver I and cadmium II have not been shown to include either inverted s terms or the special type of π terms mentioned.—W. A. **Bone**, D. M. **Newitt** and D. T. A. **Townend**: Gaseous combustion at high pressures, Pt V. The authors describe further experiments upon the explosion of hydrogen—air and carbon monoxide—air mixtures at initial pressures up to 175 atmos. It is shown, *inter alia*: That, in general, and except where N_2-activation intervenes, as in carbon-monoxide-air explosions, time for the attainment of maximum pressure diminishes as initial pressure increases. The "corrected" Pm/Pi ratios for explosion of any and all mixtures investigated increased in notable degree with initial firing pressure, due probably to increasing opacity of the gaseous medium to the radiation emitted during explosions. There were no signs of "after-burning" in any of the explosions when Pi exceeded about 10 atmos., although it could usually

be detected when $P_i = 3$ atmos.—W. T. **David**: The effect of infra-red radiation upon the rate of combustion of inflammable gaseous mixtures Two types of apparatus were employed: In one, radiation from an electrically-heated wire coil was passed into the explosion vessel through a window of fluorite or quartz. Pressure-time curves were taken during the explosion of identical mixtures, first when radiation was passed into the explosion vessel, and then when no radiation was passed in. In the other, gaseous mixtures were exploded in a vessel the interior surface of which was silver-plated, and could, therefore, be made either reflecting (by polishing) or absorbent (by coating with dull black paint), by this means it was possible to vary the radiation density of those types of radiation emitted by the burning gases during the explosion period. Pressure-time curves were taken during explosion of identical mixtures taken first when the walls of the vessel were polished, and then when blackened For hydrogen and air, carbon-monoxide and air, and methane and air mixtures, an increased rate of combustion was found in all cases when the superimposed (first type) or increased (second type) radiation could be absorbed by the reacting gases Absorption of radiation by reacting gases promotes combustion, intra-molecular energy (rotational and vibrational) of reacting molecules is the factor (or one factor) concerned in combustion —R K **Schofield** and E K. **Rideal**. The kinetic theory of surface films Surface tension—concentration curves for aqueous solution of a number of capillary active organic substances give evidence in the case of dilute solutions in support of the unimolecular character of the adsorbed films The analogy between the lowering, F, of the surface tension, and a three-dimensional gas or osmotic pressure, postulated by Traube, has been critically examined For weak solutions when F exceeds some 10 dynes per centimetre, the surface phase is relatively highly condensed, and the equation $F(A - B) = \varkappa RT$, analogous to that of Amagat connecting the pressure and volume of highly compressed gases, is obeyed. In this equation, A is area occupied by a gm mol. of active substance at interface, B is limiting area of a gm. mol. under high compression, and $1/\varkappa$ is a measure of lateral molecular cohesion. The values of $\varkappa$ for fatty acids show that at a water-air interface, lateral molecular cohesion increases with length of hydro-carbon chain There is little or no cohesion between such molecules at a water-benzene interface. Sucrose molecules do not cohere at water-mercury interface —H. M. **Macdonald**: The condition that the ratio of the intensities of the transmitted and reflected electric waves at the interface between two media is independent of their plane of polarisation For a state of steady electrical oscillation between a closed surface separating two different dielectric media and a conductor inside this surface, the condition is that the ratio of the specific inductive capacities of the two media is equal to the ratio of their magnetic permeabilities. For a medium in which the ratio of the specific inductive capacity to the magnetic permeability is constant, the intensity is constant along a ray which cuts the surfaces of constant specific inductive capacity orthogonally, when the surfaces of specific inductive capacity are concave towards an inner surface, and the specific inductive capacity diminishes outwards, the path of any other ray is concave towards the inner surface. —C. V. **Raman** and L. A. **Ramdas**: The scattering of light by liquid boundaries and its relation to surface-tension. Parts I. and II.—H. **Weiss**: The application of X-rays to the study of alloys —F. R. **Weston**: The flame spectra of carbon monoxide and water gas. The results of a spectrographic study of the flame of carbon monoxide, burning in air and various other supporting atmospheres, are described. In the flame of pure (undried) carbon monoxide, two sets of independent interactions occur simultaneously —(*a*) *direct* interactions between CO and O (*without any intervention of steam*), exciting radiations which give rise to the continuous and banded parts of the spectrum and to the characteristic blue colour of the flame, and (*b*) interactions between CO and OH_2 molecules, which originate the "steam-lines" in the spectrum When hydrogen is gradually added to the burning gas, the relative proportions of the first-named interactions diminish rather rapidly

CAMBRIDGE

Philosophical Society, May 18.—J F **Lehmann** and T H **Osgood** The passage of electrons through small apertures The velocity distribution was investigated in a beam of electrons emerging through an aperture in an anode to which they were accelerated by potential differences varying from 200 to 1000 volts For holes in thin sheet copper, the percentage of electrons in the beam with velocities equivalent to the accelerating field, as measured by retarding potentials, varied from 1 to 80 as the diameter of the hole was increased from 0·13 to 3·24 mms With copper capillary tubes of the order of 1 cm in length, the percentages were much higher for a given diameter, a 0·4 mm tube giving an 80 per cent beam This was the maximum attained under the experimental conditions

PARIS

Academy of Sciences, May 25.—M **d'Arsonval**: A new direct-current generator giving 500,000 volts. In principle this consists of a condenser charged to high potential by means of a high-tension alternating current, the alternations being separated by a two-electrode valve With a potential of 600,000 volts (continuous) a spark passes between 50 cm spheres, 28 cm. apart, the current is about 30 milliamperes. —Jean **Perrin**. Remarks on the preceding communication. If the range of the generator described can be extended to 5 million volts, it should be possible to act on the atomic nuclei and carry out transmutations on a tangible scale —A **Desgrez**, H. **Bierry**, and F **Rathery** Inorganic phosphates and hypoglycæmia produced by insulin The injection into an animal of a suitable dose of a solution of sodium or potassium phosphate, with a P_H approximating to that of the blood, intensifies and prolongs the hypoglycæmia caused by injections of insulin — C. **Camichel**, L **Escande**, and M **Ricaud** The flow of viscous liquids round an obstacle The effect of varying velocity of flow is shown in four photographic reproductions.—R **Kœhler** and C **Vaney** A new gastropod producing galls on the spines of *Dorocidaris tiara*.—M Gustave **André** was elected a member in the section of Rural Economy, in succession to the late L Maquenne —B de **Kerékjártó**: Families of surfaces and of curves —Bertrand **Gambier**: The asymptotic transformation of M. Bianchi and the curve of M. Picard of ruled surfaces the generators of which belong to a linear complex. —R. H. **Germay**: Implicit periodic functions and periodic solutions of partial differential equations.— N. **Lusin**. The projective ensembles of Henri Lebesque.— — **Eydoux**: The flow of liquids with and without velocity potential. Application to turbine buckets.—Boris **Stetchkine**: The determination in an incompressible fluid of the velocity potential due to a vortex tube.—P. Lecomte du **Noüy**: An apparatus for the rapid measurement of the surface

tension at the surface of separation of two liquids. The influence of temperature.—Stephane **Dombrowsky** The regime of concentrations established by lateral diffusion in a convection current.—M **Lardry** Study of the propagation of short waves (in wireless telegraphy) An account of the phenomena observed (fading, scintillation) of signals of wave-lengths of 450, 115, and 50 metres at distances between 180 and 4500 kilometres The superiority commonly attributed to the shorter wave-lengths was not confirmed.—E **Briner** Remarks on the origin of radioactivity It has been advanced as a difficulty against the acceptance of the theory of the spontaneously explosive atom, that the enormous emission of energy accompanying this change is irreconcilable with the exothermic synthesis of the elements starting with their primordial constituents, protons and electrons The author shows by analogies drawn from the destruction of chemical molecules that there is no real incompatibility between the radioactive atom, the destruction of which frees a large amount of energy, and the exothermic formation of the atom.—Mlle Berthe **Perrette** Contribution to the study of the isotopy of lead A comparison of lead extracted from a pitchblende (Belgian Congo) with an atomic weight of 206 14 and ordinary lead of atomic weight 207 2 The densities were radioactive lead, 11 278, common lead, 11 330, and both had the same atomic volume In the comparison of the arc spectra, the Fabry and Perot interference method was used, the diameters of the rings formed by the corresponding lines of the two isotopes being measured All the lines have shown a difference in the same sense with an increase in the wave-length for the lead with the lowest atomic weight.—Nobuo **Yamada** The long range particles emitted by the active deposit of thorium The experiments described prove that the active deposit of thorium emits only one group of α particles of 11·5 cm range, in addition to the ordinary α rays The two other groups found by Bates and Rogers were not confirmed.— — **d'Huart** The absorption of water vapour and of some other vapours by the surface of glass An apparatus is described and figured which can be used to measure the amount of water vapour adsorbed by glass surfaces It can also be used to determine the vapour density of very volatile liquids.—Paul **Pascal**. Magnetochemical researches on the formation of closed chains and nuclear groups in organic compounds.— —. **Grandadam** The purification of potassium and sodium cyanides Their melting points The purification of the alkaline cyanides can be effected by solution and recrystallisation in liquid anhydrous ammonia The melting points were determined in a silver crucible in an atmosphere of dry nitrogen, using a gold-silver thermocouple Sodium cyanide melts at 564° C., potassium cyanide at 634° C.—F **Bourion** and J **Picard** The kinetic study of the reduction of mercuric bromide by sodium formate.—V **Auger** A new type of alkaline borates; the pentaborates.—Pierre **Lesage**. Inheritance of the early character and the conservation of this character in old seeds.—P **Lavialle** The antipodes and the chalazian region of the ovule of the Dipsaceæ.—Jules **Amar** Cellular hydration and vitality.—J **Cluzet**, A **Rochaix**, and Th **Kofman**. The variations of the agglutinating power of a mixed immunoserum under the influence of a continuous electric current.—A. **Vandel**. Physiological amixia and incipient species in the isopod *Tricholiscus* (*Spiloniscus*) *provisorius*.—Phillippe **Bunau-Varilla** and Emile **Techoueyres** Induced antisepsis or, in other words, the microbacidial action exercised at a distance, without material contact, on a bacterial dilution by a very dilute solution of sodium hypochlorite.

Official Publications Received.

Bulletin of the National Research Council. Vol. 10, Part 1, No 51, March. Radioactivity Report of Committee on X rays and Radioactivity, National Research Council. By A F. Kovarik and L. W McKeehan Pp 203 (Washington National Academy of Sciences.) 2 25 dollars

Observatoire de Zi-ka-wei Notes de sismologie, No 6: Étude sur le ondes de dilatation et les ondes de condensation Principaux sismogrammes, 1924 Par le R P. E Gherzi Pp. 22+6 planches (Zi ka-wei, Chang-hai)

Annual Report of the Auckland Institute and Museum for 1924-1925, adopted at the Annual Meeting held February 27th, 1925 Pp. 37 (Auckland, New Zealand)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan Vol 15, Part 3: An Enumeration of the Butterflies and Moths from Saghalien, with Descriptions of new Species and Subspecies By Dr S Matsumura Pp 89-196+plates 8-11 (Sapporo)

Imperial Department of Agriculture for the West Indies Report on the Agricultural Department, Grenada, January-December 1924. Pp iv +11 (Trinidad) 6*d*

The Science Reports of the Tohoku Imperial University, Sendai, Japan Second Series (Geology) Vol 7, No 2 A Geological Problem concerning the raised Coral Reefs of the Riukiu Islands and Taiwan, a Consideration based on the Fossil Foraminifera Faunas contained in the raised Coral Reef Formation and the youngest Deposits Underlying It By Hisakatsu Yabe and Shoshiro Hanzawa Pp 29+6 plates (Tokyo and Sendai. Maruzen Co Ltd)

Indian Medical Research Memoirs Memoir No 3 Supplementary Series to the *Indian Journal of Medical Research* Provisional List and Reference Catalogue of the Anophelini Part 1 Provisional List of Species Part 2 Descriptive Synopsis By Lt.-Col S R Christophers. Pp 105 (Calcutta, Thacker, Spink and Co) 1 12 rupees, 2*s* 6*d*

Department of Commerce Bureau of Standards Miscellaneous Publication of the Bureau of Standards, No 63 Report of Board of Visitors to Bureau of Standards of the Department of Commerce for the Secretary of Commerce Pp iv+14 (Washington Government Printing Office) 5 cents

Hundredth Annual Report of the Committee of the Bath Royal Literary and Scientific Institution for the Year 1924 Pp 16 (Bath)

Aeronautical Research Committee Reports and Memoranda, No 960 (E 13) Variation of Engine Power with Height By H L. Stevens (B 4 Engines 50, T 1952) Pp 8+17 plates 9*d* net Reports and Memoranda, No 961 (E 14) The Variation of Engine Power with Height. By H M Garner and W G Jennings (B 4 Engines 51, T 1964) Pp 3+6 plates 6*d* net (London, H M Stationery Office)

Proceedings of the Royal Society of Edinburgh, Session 1924-1925 Vol. 45 Part 3, No 18 The Equation of Conduction of Heat By Marion C. Gray Pp 230-244 1*s* 6*d* Vol 45, Part 3, No 19 Note on Professor Whittaker's Atomic Model By John A Eldridge Pp. 245-248 9*d*. Vol 45, Part 3, No 20 Unilateral Vasoligation on the Senile Male of the Domestic Fowl By F A E Crew Pp 249-251 6*d* (Edinburgh, R Grant and Son London Williams and Norgate, Ltd)

The Physical Society of London Proceedings Vol 37, Part 4, June 15 Pp 195-267 (London Fleetway Press, Ltd) 6*s* net.

Diary of Societies.

MONDAY, JUNE 29

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof W H Moberly Some Ambiguities in the Retributive Theory of Punishment

TUESDAY, JUNE 30

ROYAL DUBLIN SOCIETY, at 4 15

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8 15.—H de B Codrington: Periods in Indian Archæology

INTERNATIONAL CONGRESS OF RADIOLOGY (at Royal Society of Medicine), at 8 30.—Reception

WEDNESDAY, JULY 1

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 2.30.—Official Opening.—At 9 P M.—Duc de Broglie: Absorption of X and γ Radiations and the Secondary Radiations which accompany them (Silvanus Thompson Memorial Lecture).

THURSDAY, JULY 2.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 10 A M

FRIDAY, JULY 3.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 10 A.M; at 9 P M.—Sir Berkeley Moynihan, Bart: The Relationship of Radiology and Surgery (Mackenzie Davidson Memorial Lecture).

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Prof. W. W. Watts. The Geology of South Shropshire (Lecture).

SATURDAY, JULY 4.

INTERNATIONAL CONGRESS OF RADIOLOGY (at Central Hall, Westminster), at 10 A M

BRITISH MYCOLOGICAL SOCIETY (Phytopathological Excursion to Cambridge).—Prof Sir R. H. Biffen and F. L. Engledow: The Inheritance of Disease Resistance.—F. T. Brooks and W. C. Moore: Silver-leaf Disease.—N. J. C. Smith: Helminthosporium Disease of Cereals.—D Weston: The Control of Bunt in Wheat.—R. C. Woodward: Apple Mildew.—Mrs. M N. Kidd: Fungal Invasion in Apples in Relation to Senescence.—S. M. Wadham: Clover Rot.—A. Smith: Perennial Rust Mycelia.—Prof. Nuttall, Dr. Hare, and Mr. Tait: Fungi Pathogenic to Man.

PHYSICAL SOCIETY OF LONDON (at Oxford).

Supplement to NATURE

No. 2904 JUNE 27, 1925

The Centenary of the Discovery of Benzene.

MICHAEL FARADAY.

A FEW weeks ago we published a special supplement in connexion with the centenary of the birth of Huxley: this week we are presenting a supplement containing the principal addresses which were delivered in the Royal Institution during the celebration of Faraday's discovery of benzene. Whereas Huxley's reputation is based as much upon his championship of evolution, of freedom of thought, and of enlightened education, as upon his researches in biology, the fame of Faraday rests almost entirely upon his striking contributions to scientific knowledge. His ambit was thus more circumscribed than that of Huxley, but his discoveries were more revolutionary, both in their effects on the development of theory and in their subsequent practical applications. In the latter connexion we refer more particularly to his discoveries of magneto-electric induction and of benzene. The electrical industries, together with the industries based upon benzene, constitute overwhelming proof—if proof be needed—of the value of research in pure science.

In attempting to estimate the place of Faraday among the world's great men, one is at a loss whether to value highest his superb skill as an experimenter, the originality and perspicacity of his thought, or his greatness as a man. Comparisons are no less difficult than they are odious, but few would gainsay that in view of the scanty material means he had at his disposal, and of the fact that he did not rely upon pupils or assistants, Faraday has had few, if any, equals as an experimenter. In the sphere of thought, he was not only a master of deductive and inductive reasoning, but also he possessed the priceless gift of a vivid and disciplined imagination. Much of his work was far in advance of his time, and hence we find his ideas still inspiring scientific research, his experimental discoveries still being transformed into great and growing industries. His views on the nature of electricity and magnetism, and on the correlation of the different forms of energy, foreshadowed in a remarkable way the results of later investigations; but, as Helmholtz said, "New ideas need the more time for gaining general assent the more original they are, and the more power they have to change the broad path of human knowledge."

Faraday's gift of original thought was most conspicuous in his purely physical work, and except in the border-line region of electro-chemistry, his chemical discoveries were mainly the outcome of great experimental skill. Thus his discovery of benzene did not result from any previous train of reasoning or concatenation of ideas, but from brilliant technique. Though chemists and physicists may dispute possession of his scientific soul, we believe that he was a physicist *au fond*; his chemistry was not, however, the "dirty" part of physics," in the words of Prof Cohen's amusing quotation. It is quite probable that our successors will cease to regard chemistry and physics as separate sciences, and if they do, Faraday, before all others, will rank as the artificer of the union. "Talent may frolic and juggle, genius realises and adds," said Emerson, and Faraday's supernormal gifts of insight and experimental skill will always mark him out as one of the greatest master-builders of physical science.

To Faraday's character as a man, we have most eloquent tributes from Tyndall, Bence Jones, Gladstone, Dumas, and others. Actuated by a laudable if unscientific motive, biographers are apt to discard material which reflects adversely upon those whose lives they describe. In the case of Faraday they cannot lay themselves open to this imputation; his failings were extraordinarily few, and his real life was quite as beautiful as any romantic or hero-worshipping biographer could imagine it to have been. Except in the sphere of religious belief, Faraday and Huxley had many common traits. Each had a very strong sense of justice, and an unswerving respect for truth, to which was added an unquenchable enthusiasm for the verities of science. The lives of both were permeated by the highest moral purpose, and no one who tries to follow in their footsteps can but feel that great as were their contributions to natural knowledge, even greater were their characters as men.

Faraday as a Chemist.[1]

By Sir William J. Pope, K.B.E., F.R.S., Professor of Chemistry, University of Cambridge.

MICHAEL FARADAY was born in 1791, as the son of a working blacksmith in London. During the distress of 1801, when corn rose to more than 9*l* a quarter, his family received public relief, and one loaf of bread was allotted weekly to the nine-year-old child His systematic education was rudimentary in character, for in his thirteenth year he became errand-boy to a bookseller in the neighbourhood of Manchester Square, and was entrusted with the duty of distributing the Sunday newspapers

So lowly an introduction to life might seem to furnish but a slight foundation for a great scientific career Yet Faraday became Director of the Laboratory of the Royal Institution in his thirty-fourth year, and succeeded Sir Humphry Davy in the chair of chemistry in 1827; on his death in 1867 he was mourned by practically every learned academy in the civilised world as one of the foremost of the great chemists and physicists of the first half of the nineteenth century. Many of Faraday's discoveries and much of his mode of interpreting chemical observations still persist as sources of inspiration to the chemist of a century later The task of tracing the career of this great scientific luminary, of trying to decipher the stages in his major discoveries and of learning how his dominating position in science was attained, is an interesting one, it is also an illuminating one as showing how the exercise of industry and ability can reduce to negligible proportions the effect of faulty early education and of absence of family support.

Faraday was apprenticed as a bookbinder to his employer in 1805; his indentures note that "in consideration of his faithful service no premium is charged" He has told us that whilst an apprentice he read a great number of scientific books which came under his hands, and the correspondence which he left shows that he was in the habit of discussing with keen enthusiasm a large variety of scientific topics, he attended a few lectures on natural philosophy by certain private individuals who were in the habit a century ago of advertising such discourses. Early in 1812 a customer of his master's shop enabled him to attend four of Sir Humphry Davy's lectures in this theatre; we are told that he sat in the gallery just above the clock, and that he carefully elaborated his notes upon the experiments shown and the explanatory discourses. Faraday's contemporary correspondence makes it clear that he became captivated by the charm of manner and the skill in exposition and experiment of the master; he got into contact with Davy, and on March 1, 1813, was appointed by the Managers as assistant in the Laboratory of the Royal Institution.

Faraday's scientific career had commenced, but it had commenced in circumstances which would have discouraged any but the most intrepid. The first piece of work in which he was called upon to assist Davy consisted in experiments on the newly discovered nitrogen chloride; six weeks after he came to the Royal Institution he was writing to a friend describing the injuries from which he and his master were suffering by the premature explosion of this capricious substance Although this frequency of bodily hurt must have been very disconcerting to an entire novice in chemical experiment, Faraday seems to have accepted it without demur or complaint, and as a necessary incident to the occupation which he had now definitely determined to adopt Indeed, a month later he writes his friend at some length, and with no little perspicacity, upon the conduct of lectures and the behaviour of lecturers. He observes that "polite company expect to be entertained not only by the subject of the lecture, but by the manner of the lecturer, they look for respect, for language consonant to their dignity, and ideas on a level with their own." This youth of twenty-one years of age was by no means unprecocious; he observes that "a lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him, and his mind clear and free for the contemplation and description of his subject."

In the autumn of 1813 Sir Humphry Davy left England for an extended tour through France, Italy, and Switzerland, taking Faraday with him as assistant and amanuensis This journey, which lasted about eighteen months, appears to have been the only occasion on which Faraday left England for any length of time, and it undoubtedly exercised a great influence on his future life. The travellers carried chemical apparatus with them, visited a large number of foreign chemists, and themselves experimented on the novel problems laid before them. They experimented with the newly discovered element, iodine, with which Ampère provided them, and of course prepared the explosive nitrogen iodide; they visited Chevreul's laboratory, and attended a lecture by Gay-Lussac. Leaving Paris they drove across the Alps into Italy; at Genoa they studied the electrical discharge from the torpedo fish, and spent some time in Florence burning diamond with the aid of the great burning-glass in the Accademia del Cimento; they visited Vesuvius, made the acquaintance of Volta, and Faraday made copious notes on the firefly and the glow-worm.

[1] Discourse delivered at the Royal Institution on Friday, June 12.

They collected the natural inflammable gas at Pietra Mala, and identified it as methane in the laboratory of the Florentine Academy.

This lengthy journey, much of it in a country with which England was at war, must have been of inestimable benefit to Faraday; he acquired some acquaintance with the outside world, and the insularity and indeed petulance which he occasionally displayed in his letters concerning the manners and customs of people with whose language he was unacquainted, reveal his need for the wider experience thus afforded him. He saw the commanding position which Davy's genius as an experimental philosopher had acquired for him in European science, and, what was possibly of even more permanent importance, he had occasion to realise that the homage deservedly paid to his great master had led, perhaps, to some deterioration in those personal qualities which might be expected to accompany intellectual eminence.

In May 1815 Faraday recommenced work at the Royal Institution, and shortly afterwards took possession of living apartments in this building. It must be remembered that this period was one of extraordinary interest in connexion with chemical science. The sound experimental work of the previous century had freed the natural philosopher from the mystical and metaphysical trammels imposed by the alchemists, and had just led, through the work of Lavoisier, to an appreciation of the fact that quantitative measurements of weights and volumes had become the basis of an imminent great development in chemistry. Shortly before, Davy had overthrown Lavoisier's view that oxygen was the acid-forming element, had shown that hydrogen chloride contains no oxygen, and had proved that "oxymuriatic acid" was an elementary substance which he called chlorine; he had displaced caustic soda and caustic potash from their position as elements, and isolated from them the elementary metals sodium and potassium. Dalton had just enunciated the atomic theory, and Avogadro had stated his famous hypothesis that equal volumes of gases contain the same number of molecules under similar conditions of temperature and pressure; both these fundamental statements of principle were destined to survive to the present day as logical deductions from experimental observation. The next few years were to see the popularising of chemical science by the introduction of Davy's safety lamp for use in coal mines, an invention which was probably greater than any other asset in determining the increasing industrial activities of Great Britain.

This was the atmosphere in which Faraday found himself when he made his permanent home at the Royal Institution in 1815; his publications of the succeeding few years show that he occupied himself busily in expanding his knowledge of science and in developing his remarkable talents as an experimenter.

Faraday's first contribution to chemical knowledge was a very modest one, and consisted in the examination of an Italian lime of volcanic origin; this was published in 1816, and was followed by some comments by Humphry Davy. His next essay was more ambitious. In 1816 the professor of mineralogy at Cambridge, E. D Clarke, published a paper on the uses of the oxy-hydrogen blowpipe, an instrument which had been introduced by the American chemist, Robert Hare, in 1802. But whilst Hare fed hydrogen and oxygen separately into the blowpipe, Clarke proposed actually to use a mixture of the two gases in the requisite proportion, this involved the introduction of some device for preventing the flame from striking back and causing the explosion of the mixed gases in the reservoir At this time Davy had perfected his safety lamp for use in the coal mines, and during this work had been led to reflect upon the various ways in which flame could be prevented from travelling through a body of inflammable gas; at Davy's suggestion Clarke caused the mixture of hydrogen and oxygen to pass through a short capillary of glass before entering the blowpipe The explosion wave was extinguished by the cold walls of the capillary, and thus the risk of the explosion of the reservoir of gas was diminished, the risk was not entirely avoided, for Henry Gunning, in his "Reminiscences of Cambridge," notes the dangerous character of the oxy-hydrogen blowpipe as used by Prof. Clarke, who was a somewhat eccentric and superficial enthusiast. At all events, Clarke succeeded in volatilising gold and in burning diamond with his blowpipe, and in 1817 Faraday published a note describing the repetition and extension of Clarke's results; it will be recognised that no little experimental skill had to be exercised in order to avoid the occurrence of a disastrous explosion. Shortly after, Faraday described an apparatus in which Davy's experiment of burning diamond can be performed in an enclosed space; the diamond is carried in a platinum capsule suspended in a glass globe filled with oxygen, and a jet of hydrogen, ignited by an electric spark, is used to heat the diamond to its ignition temperature.

Faraday's earlier papers were of the nature of short notes, and were published in the *Quarterly Journal of Science*; this was the organ of the Royal Institution, and had been started by Brande in 1816. Faraday's first paper in the Philosophical Transactions of the Royal Society appeared in 1821, and described the discovery and properties of hexachloroethane, $CCl_3 . CCl_3$, and its conversion into tetrachloroethylene, $CCl_2 . CCl_2$. Six months later he described and analysed another

compound of carbon and chlorine, which Dr. Hugo Müller showed later to be hexachlorobenzene, C_6Cl_6; by a curious coincidence Faraday thus had a simple derivative of benzene in his hands several years before he discovered benzene itself.

It is remarkable that in these papers, and in their author's other incursions into organic chemistry, no trace is found of a kind of mysticism which attended the treatment of carbon compounds almost until the middle of the nineteenth century. Lavoisier had shown that the majority of chemical substances produced as the result of animal or vegetable life contain carbon, and we still retain the name organic as descriptive of the carbon compounds. About 1760 the French naturalist, Buffon, stated that "there exists a living organic substance, universally distributed throughout all animal or vegetable substances, which serves equally for the nutrition, for the growth, and for the reproduction of animals and vegetables." Even in 1849 Berzelius wrote that "the elements seem to obey quite other laws in living nature than in inorganic nature, the products which result from the reciprocal action of the elements thus differ in the two cases If we could succeed in learning the cause of this difference we should hold the key to the theory of organic chemistry; but this theory is so well hid that we have no hope of discovering it." The same idea of the existence of a vital force as provocative of chemical changes in living matter is common to these two writers, separated by nearly a century. The hexachloroethane and the tetrachloroethylene were typical organic compounds; they were produced from ethylene, which in turn had been prepared from alcohol obtained by the fermentation of sugar. It is characteristic of Faraday's broad outlook upon chemistry that he should have dealt with organic compounds as subject to the same laws as govern chemical substances in general; in this modernity of conception he anticipated many of his successors

Whilst this work was in progress Faraday was engaged in an investigation of the alloys of steel in conjunction with James Stodart; this had for its object the improvement of steel intended for the manufacture of cutting instruments and the diminution of the tendency to rust. A large number of new alloys were prepared and studied; some, such as those with platinum, had little tendency to rust, those with rhodium could be forged and tempered, and the silver-steel alloys were used for some time for the manufacture of such articles as fenders. Although Faraday occasionally presented his friends with razors forged from certain of his new alloys, the work found no considerable technical applications; the modern extensive use of nickel-steel and chromium-steel, both of which Faraday prepared, suggests that the work was in advance of the needs of the times.

Another piece of work undertaken in 1822 led to results of far-reaching importance. Humphry Davy had shown that the supposed solid chlorine obtained by cooling moist chlorine is really a hydrate of this element; Faraday determined the composition of this unstable compound as, roughly, $Cl_2 . 10H_2O$, but the exact composition is not yet known. On sealing the substance up in an inverted V-shaped tube, and warming the arm containing the chlorine hydrate, Faraday observed that chlorine was given off, and became condensed to a yellow liquid in the empty arm; the hydrate had decomposed and the evolved chlorine had been liquefied by the pressure set up during its liberation. On cooling the arm containing the liquid chlorine to 0° C. and then opening the tube, part of the chlorine boiled off and the remainder became, in consequence, so cooled that it remained liquid under atmospheric pressure Faraday estimated that the temperature so attained must have been lower than −47° F., and, as we now know, it is about −47° F. He also found that chlorine could be liquefied at ordinary temperatures by four or five atmospheres pressure. The novel device of liquefying a gas by taking advantage of the pressure set up in a closed vessel by liberating the gas in a closed vessel, was clearly capable of wide application, and its inventor immediately used it for the liquefaction of sulphur dioxide, hydrogen sulphide, chlorine dioxide, nitrous oxide, cyanogen, ammonia, and hydrogen chloride. His interest in the subject aroused, he proceeded to liquefy a number of more refractory gases by cooling them under pressure in a bath of solid carbon dioxide and ether, and also succeeded in converting hydrogen bromide, hydrogen iodide, sulphur dioxide, hydrogen sulphide, nitrous oxide, ammonia, and other gases into crystalline solids. The systematic study of the liquefaction of gases initiated by Faraday provided the foundation for much of the most brilliant work done within these walls by another great experimental genius, the late Sir James Dewar.

We now arrive, in this brief survey of Faraday's chemical work, at the moment of that important discovery which laid the foundation of more than one-half of modern organic chemistry and of one of the most important branches of chemical industry; this was the discovery of benzene, which was announced to the Royal Society on June 16, 1825.

Early in the last century the Portable Gas Company was engaged in making illuminating gas by dropping whale or cod oil into a furnace maintained at a red heat; the inflammable gas produced by this process of destructive distillation was subjected to a pressure

of about thirty atmospheres and stored in portable vessels. These latter were then transported to private houses and other buildings, and the gaseous contents burnt for illuminating purposes. During the process of compression a liquid was deposited, each 1000 cubic feet of gas yielding nearly a gallon of this oil Faraday subjected this condensed liquid to careful examination, and separated from it a compound of carbon and hydrogen which he termed bicarburet of hydrogen; he made a detailed study of this substance, and the analytical results which he obtained, translated into the modern nomenclature, give its molecular composition as C_6H_6.

The memoir in which Faraday describes the isolation of this hydrocarbon is written in very simple language, but it reveals throughout the handiwork of a genius in experimentation and of an unrivalled master in the interpretation of experimental results Thus, at this early date, and with the very modest appliances at his hand, the experimenter separated benzene in a state of purity from a very complex mixture, he found that it solidified on cooling, and gave its melting-point as 5 5° C., the correct melting-point being 5 44° He determined the composition of the hydrocarbon by a method so ingenious that it might well tax the skill of the modern worker He evaporated the hydrocarbon into a known volume of oxygen, noted the increase in gaseous volume, exploded the mixture in the eudiometer and noted the diminution in volume, then treated it with caustic potash solution and observed the further diminution in volume due to the removal of the carbon dioxide. The data thus obtained give the proportion of carbon to hydrogen, and also the density of benzene vapour as compared with hydrogen as the standard; Faraday hence calculated the vapour density as 39, which is the correct value.

This exhibition of real mathematical power as a mode of unravelling a complicated skein of quantitative data was followed by a profound study of the chemical behaviour of the new substance. Faraday noted that chlorine is without action on benzene in the absence of sunlight, but that when the mixture is exposed to sunlight, vigorous action occurs with evolution of hydrogen chloride; he succeeded in separating the solid chlorination product, obviously *p*-dichlorobenzene, from the liquid residue containing the *o*-isomeride. This was the first occasion on which the catalytic activity of sunlight in promoting the action of halogens on the aromatic hydrocarbons had been observed, and it is perhaps superfluous to remark that this particular aspect of catalytic activity is still growing in importance and is still a subject for scientific study.

Many other points in this memoir of Faraday's might well call for distinction, but it will suffice to recall the comment passed upon the paper by Berzelius: "One of the most important chemical investigations which has enriched chemistry during 1825 is without doubt that of Faraday on the oily compounds of carbon and hydrogen obtained by compressing the gases obtained by the decomposition of fatty oils" The great Swedish chemist, himself the intellectual giant of the quantitative chemistry of his day, was impressed less by the new facts recorded than by the consummate art exercised in their elicitation and by the conviction that a new epoch had dawned in organic chemistry.

The bicarburet of hydrogen which Faraday separated from the gas obtained by the destructive heating of an animal oil was prepared by an entirely different means some ten years later. Mitscherlich obtained it in 1834 by distilling benzoic acid with lime, and proposed to give it the name benzin because of its relation to benzoic acid, which in turn derived its name from its original source, gum benzoin, Liebig objected to this name and proposed that it should be named benzol. Liebig's statement, made in 1834, that benzol could be obtained from coal, is possibly based on a misreading of Faraday's paper in which he states that he had not been able to obtain it from coal-tar The presence of benzol in coal-tar seems to have been first noted by John Leigh in 1824, and this observation was confirmed by Hofmann in 1845; in 1849 Mansfield was manufacturing benzol on a factory scale from coal-tar, and indeed lost his life in 1856 as the result of a fire which occurred whilst he was preparing the compound The name benzol still survives as descriptive of the technical product, but the chemical name of the substance has now become benzene.

Benzene is the first member of a long series of compounds of carbon and hydrogen, the so-called aromatic hydrocarbons, which are closely related in chemical constitution and chemical behaviour. The second member of the series is toluene, C_7H_8, which was discovered by Pelletier and Walter in 1837, and is also separated in large quantities from coal-tar. Before discussing the modern importance of this particular series of aromatic hydrocarbons, it may be well to refer to others with which Faraday was closely associated.

The hydrocarbon naphthalene was observed as a crystalline deposit in an apparatus used by Garden in 1819 for the distillation of coal-tar; its separation from coal-tar was described by John Kidd, the professor of chemistry at Oxford, in January 1820. The chemical composition of naphthalene was determined by Faraday early in 1826; Faraday prepared the two isomeric derivatives, now known as the naphthalene α- and β-sulphonic acids, and contributed further particulars concerning the behaviour of this hydrocarbon. The interest aroused in the components of coal-tar by Faraday's

remarkable work on benzene and naphthalene led to a rapid increase in our knowledge of the composition of this raw material. In 1832 Dumas and Laurent separated anthracene from it, and, up to the present time, some thirty aromatic hydrocarbons, and more than that number of other aromatic compounds, have been extracted from this product of the distillation of coal.

It is worth while, if merely as an object-lesson exhibiting the vast influence which can be exerted on the world's affairs by some originally modest piece of scientific research, to consider the scope and magnitude of the progress made as a result of Faraday's discovery of benzene one hundred years ago.

The whole of the great coal-tar colour industry sprang from Faraday's study of coal-tar. In 1856 the late Sir W. H. Perkin made the first coal-tar colour, Perkin's Mauve, from coal-tar benzene; and at the great Exhibition of 1862 a large number of such artificial colouring matters were displayed. So rapid had been the progress made during half-a-dozen years that in 1862 Hofmann was able to write as follows concerning benzene.

"For years the newly discovered compound could claim scientific interest only. In this investigation, as indeed throughout the whole series of his immortal researches, Faraday's object was the elaboration of truth for its own intrinsic value and beauty; and in the same spirit has the work been continued by those who, after Faraday, engaged in the further scientific examination of the subject. Nobody, in those early days of benzol, when the substance simply existed as a laboratory curiosity, dreamed of the brilliant career looming in the distance for this body, nor of the marvellous transformations it was destined to undergo."

Since the early days when Hofmann was moved to use these words, the development of coal-tar colour manufacture has proceeded with progressive rapidity, the number of coal-tar colours now recognised as of technical value is of the order of 1200. Whilst the earlier artificial dyestuffs, although brilliant in colour, were often fugitive to light or to washing, we are now in possession of coal-tar colours which are more fast to light and to washing than indigo, madder, or any of the stable dyestuffs known to our ancestors. Many of the newer aromatic artificial dyes persist even when the fabric on which they are deposited has rotted away. The late Lord Playfair, and many other chemists, saw that the coal-tar colour industry was likely to influence in a remarkable manner the industrial fortunes of Great Britain. Hofmann put this view forward in 1862 in a remarkable passage:

"For, if coal be destined sooner or later to supersede, as the primary source of colour, all the costly dyewoods hitherto consumed in the ornamentation of textile fabrics; if this singular chemical revolution, so far from being at all remote, is at this moment in the very act and process of gradual accomplishment—are we not on the eve of profound modifications in the commercial relations between the great colour-consuming and colour-producing regions of the globe? Eventualities, which it would be presumptuous to predict as certain, it may be permissible to forecast as probable; and there is fair reason to believe it probable that, before the period of another decennial Exhibition shall arrive, England will have learned to depend, for the materials of the colours she so largely employs, mainly, if not wholly, on her fossil stores. Indeed, to the chemical mind it cannot be doubtful that in the coal beneath her feet lie waiting to be drawn forth, even as the statue lies waiting in the quarry, the fossil equivalents of the long series of costly dye materials for which she has hitherto remained the tributary of foreign climes. Instead of disbursing her annual millions for these substances, England will, beyond question, at no distant date become herself the greatest colour-producing country in the world; nay, by the strangest of revolutions, she may ere long send her coal-derived blues to indigo-growing India, her tar-distilled crimsons to cochineal-producing Mexico, and her fossil substitutes for quercitron and safflower to China, Japan, and the other countries whence these articles are now derived."

This pronouncement of Hofmann is interesting in that it involves two propositions, one correct and the other incorrect. The instinct and wide experience of the chemist told him, and told him correctly, that the coal-tar dyes were destined largely to replace the vegetable colouring matters and to provide the textile manufacturer with increased opportunities for the production of new effects; but when he took for granted that the new discovery would find vigorous commercial development in the country of its birth he was forming an opinion on a subject less his own than chemical science. Within a few years Great Britain was exporting coal-tar to Germany for dyestuff manufacture, and, whilst artificial colour manufacture languished here, Germany forged ahead and soon dominated all others in the new industry. Indigo-planting and indigo preparation did indeed dwindle into insignificance, largely because no concerted effort was made to apply scientific methods to the improvement of methods which had remained unchanged for perhaps a thousand years; but it was Germany which exported artificial or coal-tar indigo to India and not Great Britain.

It has just been hinted that scientific cultivation and scientific methods of separation might have enabled natural indigo to hold its own against artificial indigo produced from the components of coal-tar; there is indeed solid foundation for the belief that natural indigo, had its production not been woefully mismanaged, would never have been supplanted by the artificial material. It would appear likely that the percentage of colouring matter yielded by the indigo plant might be greatly increased by scientific breeding and by improved methods of extracting the colour; the percentage of sugar obtained from the sugar beet by judicious selection of seed and careful development of methods of extraction was raised from little more than 5 per cent. to about 20 per cent. on the weight of the

beet. Furthermore, and for reasons which need not now be discussed, it seems clear that natural indigo is of distinctly greater value as a dyestuff than the artificial product. These facts were realised by the Government of India many years ago: a scheme of research work was launched, financed by the State, and notable advances were made in the manufacture of natural indigo. But at the moment when it had become clear that indigo planting could be given a new and profitable lease of life, the Indian Government, apparently from motives of economy, abandoned the research scheme, the considerable expenditure of money which had been incurred thus represented, for all practical purposes, an extravagant waste of money. It seems at first sight irrational to spend a large sum of money in proving the truth of a scientific forecast as to how a particular scientific industry can be made to flourish and to abandon the project at the moment of fructification; at the same time, the fact that this remarkable method of procedure is the standard method adopted by British Governments would suggest that it has a sound economic basis

Whilst little or nothing was done to stimulate the cheap production of natural indigo, neither effort nor money was spared in the attempt to manufacture coal-tar indigo in the German colour works; it has been stated that 2,000,000*l.* was spent on chemical research and technical development before synthetic indigo was put upon the market. The vast amount of chemical and technical experience gained during this great enterprise did not lead to the production of indigo alone; many compounds closely allied to indigo and possessing value as dyestuffs were also made. Included among these is the traditional Tyrian purple, which is contained in the secretions of a small marine snail.

Again, the competition amongst coal-tar dyestuff manufacturers led to new developments in connexion with the manufacture of entirely novel dyes of like stability to indigo, although belonging to entirely different classes of chemical compounds. Many of these, grouped together as the so-called "vat-dyestuffs," are derivatives of the hydrocarbon anthracene which has been previously mentioned; they can be produced from anthracene separated from coal-tar. But coal-tar anthracene is costly, whilst the two hydrocarbons with which Faraday was so closely associated, benzene and naphthalene, can be extracted from coal-tar in large quantities at but little expense. As an illustration of the thoroughness with which chemical skill has been applied to the solution of the economic problems which arise in the manufacture of artificial colouring matters may be quoted the fact that the cheap raw materials, benzene and naphthalene, can now be used instead of anthracene itself in the manufacture of the dyestuffs relating to anthracene. Naphthalene can be partially burnt in the air so as to yield phthalic acid, this phthalic acid can be caused to condense with benzene to give anthraquinone. The anthraquinone thus manufactured can be used to replace that previously obtained from the costly anthracene, and can be utilised in the manufacture of the better-class vat-dyestuffs.

Whilst the manufacture of coal-tar dyes grew to vast dimensions owing to wise development and exploitation, other industries and fields of knowledge also benefited In course of time it was found that Faraday's benzene was the starting material for many aromatic substances of use in medicine, in photography and in many other arts Furthermore, the coal-tar hydrocarbons, benzene and toluene, are the raw materials from which the high explosives, picric acid and trinitrotoluene, are manufactured At the outbreak of the War, no picric acid was being made from benzene, and no trinitrotoluene had ever been made on a large scale in Great Britain. This was of course well realised on the Continent; to what extent the known unpreparedness of Great Britain for the manufacture of the staple high explosives was a factor in precipitating war cannot now be ascertained

The set of great industries involved in the manufacture of artificial dyestuffs, pharmaceutical products, and military and naval high explosives are thus closely allied Faraday's discovery of benzene and its analogues is also important in connexion with liquid fuel used in the ordinary internal combustion engine. Certain of the naturally occurring petroleums contain large proportions of aromatic hydrocarbons, such as benzene, and the fact that a petroleum from Borneo, containing about 20 per cent. of benzene and toluene, was available in 1914, was a very material relief to the difficult situation created by the impossibility of immediately preparing large quantities of raw materials from coal-tar for the manufacture of high explosives. Benzene and toluene from coal-tar are now largely used for blending with petrol from overseas and for improving its efficiency as a fuel.

In the year 1825 Faraday undertook, at the request of the Council of the Royal Society, a lengthy and laborious experimental study of the manufacture of optical glass; the investigation extended over four years, and was fruitful in that it provided a great deal of accurate and precise data as to the conditions to be desired or to be avoided in the making of glass for optical instruments. The notable positive result of the work was the discovery of the so-called heavy glass, which consists largely of a lead borosilicate and has very high refractive power. The expenses incurred in

carrying out this work were amongst the objects of a violent attack levelled against the president and Council of the Royal Society in 1830 by Sir James South. The "heavy glass" was destined later to serve in Faraday's discovery in 1845 of the rotation of the plane of polarisation of light when passed through a transparent medium in a strong magnetic field, this property, that of magnetic rotatory power, took its place amongst the important physical constants of chemical substances as a result of the work of the late Sir W. H. Perkin

Yet another brilliant piece of Faraday's experimental chemical work remains to be mentioned. He had noted that films of beaten gold of some 1/280,000th of an inch in thickness are translucent, and that the transmitted light is green in colour; from this observation he was led to study the transmitted colour of still thinner films of gold and other metals, and to the conclusion that glass, fused with the addition of a trace of a gold salt, owes its ruby colour to the diffusion throughout the mass of minutely divided gold The reduction of metallic gold in aqueous solution also engaged his attention, and he concluded that the bright red-coloured solutions thus obtained owed their colour to the diffusion of minute particles of metallic gold throughout the liquid. These coloured and apparent solutions of metallic gold in water are very stable; their study by Faraday in 1857 was an obvious prelude to the classical studies of colloidal solutions published by Thomas Graham, the Master of the Mint, in 1861

So far I have dwelt, perhaps with too much insistence, on Faraday's pre-eminence as an experimenter, and, possibly again in too accentuated a manner, with the world-extended influence of his chemical work on the subsequent history of our planet Such possible defects call for an apology. Faraday came forward as an experimental genius at a time when the chemist was forced to work with the aid only of ordinary domestic appliances, and when he had to make for himself every item of the apparatus which he desired to use. His "Chemical Manipulation," published in 1829, provides a fund of information concerning details of chemical experimentation of which the chemical student of to-day is entirely ignorant. We have progressed so far in our experimental study of chemical phenomena that the investigator is now but little dependent on his own manipulative skill, and has become largely subservient to the ingenuity of the scientific instrument maker. Again, an apparently non-utilitarian experimental discovery made in one generation seems naturally to become the corner-stone of some gigantic industrial development in the next decade. A perusal of Faraday's experimental work furnishes ample material in support of this thesis; and, to come nearer to the present day, many of those present to-night had the privilege of witnessing those fundamental experiments on the liquefaction of gases, shown in this theatre by Sir James Dewar, which have become the foundation of great industries.

It would be a mistake to attempt to measure the achievements of Faraday on a scale derived from a consideration of the immediate material benefits to the world which have accrued from his work. Probably no man, with the possible exception of Newton, has ever exercised throughout a century such a persistent directive impulse to the activities of a huge body of scientific workers This is the more strange in that Faraday was essentially a solitary worker; the long list of his published papers includes but two in which he is named as a joint author It would almost seem that the man was endowed with such consummate skill as an experimenter that any collaborator of his day would have impeded the progress of a joint investigation It might perhaps have been anticipated that one so much accustomed to work alone, and as a pioneer far ahead of most of his contemporaries, would have tended towards narrow specialisation and have gradually lost interest in other branches of scientific activity by reason of intense cultivation of his own field of investigation Some justification for such an expectation may be sought in the fact that although he was the first secretary of the Athenæum Club, he resigned the position after one year of office, and that he declined nomination to the presidency of the Royal Society on the ground that it would impede his experimental work. But the lengthy correspondence of Faraday with Schönbein, Liebig, Whewell, Wheatstone, Agassiz, Dumas, Wollaston, Herschel, de la Rive, Gay-Lussac, and a host of other great contemporaneous scientific men, shows that his interests were widespread, and that he bore always in mind his primary concern for the advancement of natural philosophy as a whole. One of the most acute judges of his fellow-men, the Count Camillo Cavour, records an appreciation which is worthy of quotation; he found Faraday "without a waistcoat, in a ragged old coat, looking for all the world like a sixteenth-century savant. But one can see that he has great rapidity of perception and quickness of decision—two qualities which lead almost instinctively to these great discoveries. There is not a scrap of scientific conceit about him."

In this conservation of a wide scientific interest, so difficult for an isolated worker, the nature of Faraday's duties in the Royal Institution must have played a great part. One of his major tasks consisted in expounding the results of current scientific progress to a cultured, though not a specialist audience; his sense of responsibility towards that audience led him so to train his powers that he became the most efficient popular

exponent of science of his day. His lectures to children on the chemical history of a candle show that he was an unrivalled master of lucidity of exposition and a genius in the device of simple but convincing illustrations.

It must not, however, be imagined that Faraday confined himself to the discovery and exact statement of experimental facts without thought for their theoretical significance. His respect for a bold and far-reaching generalisation, put forward as a mathematical interpretation of facts—and this is what is meant by a theory—is expressed in many of his writings He begins one of his papers with the following passage:

"That wonderful production of the human mind, the undulatory theory of light, with the phenomena for which it strives to account, seems to me, who am only an experimentalist, to stand midway between what we may conceive to be the coarser mechanical actions of matter, with their explanatory philosophy, and that other branch which includes, or should include, the physical idea of forces acting at a distance, and admitting for the time the existence of the ether, I have often struggled to perceive how far that medium might account for or mingle with such actions generally, and to what extent experimental trials might be devised, which, with their results and consequences, might contradict, confirm, enlarge, or modify the ideas we form of it, always with the hope that the corrected or instructed idea would approach more and more to the truth of nature, and in the fulness of time coincide with it"

The literature of science may be searched in vain for a more sympathetic and a more accurate definition of the relation which should exist between the pure experimenter and the mathematical interpreter of the observed facts; and because Faraday was both. Clerk Maxwell, who was the first to translate Faraday's brilliant conceptions into mathematical language, and to apply to them all the powerful methods of the mathematical workshop, observed that:

"The way in which Faraday made use of his idea of lines of force, shows him to have been in reality a mathematician of a very high order—one from whom the mathematicians of the future may derive valuable and fertile methods."

This is the deliberate opinion of one who was not given to exaggeration, and who, in the course of a short life, contributed more perhaps than any other to the development of mathematical physics in the Victorian period. That Clerk Maxwell's judgment was sound is obvious to all who have had occasion to study the remarkable series of experimental researches in electricity published by Faraday between 1831 and 1860; early in these classical investigations Faraday succeeded in forming very clear ideas concerning the manner in which an electric current operates in the decomposition of water or of salts in solution. He showed that when water is electrolysed the quantity decomposed is exactly proportional to the quantity of electric energy which has passed, and that the products of the decomposition can be collected and measured "with such accuracy as to afford a very excellent and valuable measurer of the electricity concerned in their evolution." He showed further that in all cases the quantity of chemical decomposition is exactly proportional to the quantity of electricity which has passed through the electrolyte, and that a given quantity of electric energy liberates chemically equivalent amounts of the metals during the electrolysis of metallic salts. In this way Faraday was able to determine a series of numbers representing the electrochemical equivalent of the elements, and to show that the electrochemical equivalent is the same as the chemical equivalent. It remained for a later worker, Sir Edward Frankland, to formulate the conception of valency, to point out that the true atomic weight of an element, divided by the valency, gives the chemical equivalent, and so to pave the way for securing the atomic theory in its present impregnable position The work of Faraday on electrolysis was one of the essential steps taken during the nineteenth century to realise what Newton foresaw when he remarked:

"It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable movable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as must conduce to the end for which He formed them; and that these primitive particles, being solids, are incomparably harder than any porous body compounded of them, even so hard as never to wear or break in pieces; no ordinary power being able to divide what God Himself made one in the first creation"

But still more far-reaching consequences resulted from Faraday's electrochemical work; he often expressed his conviction that the forces termed chemical affinity and electricity are one and the same, and he had been led to associate a definite quantity of electricity with the liberation of the atomic unit of an element from combination. There must thus exist a definite minimum unit of electricity, and, as Helmholtz indicated more definitely in 1880, not only matter but also electricity itself has an atomic structure The discoveries of the last thirty years, which have resulted in the isolation of the atom of negative electricity—the electron—and the identification of the atom of positive electricity with the positively charged hydrogen atom, are the logical outcome of the work of Faraday.

To the chemist the discussion, applications, and extension of Faraday's electrochemical conceptions have been a fruitful source of inspiration and progress for nearly a century; as time passes on, those conceptions are seen to increase continually in fundamental significance. It cannot be doubted that when the second centenary of the discovery of benzene is honoured in this theatre a hundred years hence, my successor will be able to point to consequences still more fundamental and far-reaching, of the work and thought of perhaps the greatest experimental genius the world has ever seen.

The Faraday Benzene Centenary.[1]

By Prof Henry E. Armstrong, F.R.S.

An indescribable feeling of deepest reverence thrills those who know that they are within a holy of holies when standing at this table whence Davy and Faraday and Dewar disclosed their discoveries to the world

Consider the immensity of outlook it commands A few days ago, the glories of Tut-ankh-Amen's most wonderful tomb were depicted, in minute detail, upon the screen behind me We could realise that man stood higher, in the decorative arts, several thousand years ago, than he does to-day– that man was then deeply reverent in his beliefs In stark contrast is the change in our civilisation—we call it advance – made within the past century, through the application of the discoveries discoursed of within these walls: in large measure fired by the tiny spark first shown to the world, at this table, in 1831 What reverence have we for such a discovery? Our men of letters pay no heed to it The public at large has no knowledge thereof.

Chemists desire to show, by this commemoration, that they are persons mindful of the words of the ancient poet and preacher:

Let us now praise famous men
And our fathers that begat us
The Lord hath wrought great glory by them
Through His great power from the beginning.
Such as did bear in their kingdoms,
Men renowned for their power,
Giving counsel by their understanding
And declaring prophecies
Leaders of the people by their counsels
And by their knowledge of learning meet for the people,
Wise and eloquent in their instructions.

"Of them that have left a name behind them," Faraday is one of the greatest, certainly the greatest experimental philosopher the world has yet known. A Sandemanian, deeply religious, from his childhood upwards, throughout life, he advisedly kept his "science" apart from his religion but his moral faith was ever the background of his scientific productivity His work was all conceived and executed in a deeply religious spirit. It will only be by following his example that wisdom will be made the religion of the people. He painted himself, his attitude during the whole of his career, in a lecture he gave in 1816, when only twenty-five years old, in saying—

"The philosopher should be a man willing to listen to every suggestion but determined to judge for himself He should not be biassed by appearances; have no favourite hypothesis; be of no school and in doctrine have no master. He should not be a respecter of persons but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."

Speaking at this table, in May 1854, addressing His Royal Highness, the Prince Consort, who occupied the chair, Faraday said: "I take courage, Sir, from your presence here this day, to speak boldly that which is on my mind." The lecture was on "Mental Education." In it he dealt with the need of self-education, through attention to "natural things," with the object of improving the faculty of judgment and making it proportionate.

"I will simply express my strong belief," he said, "that that point of self-education which consists in teaching the mind to resist its desires and inclinations, until they are proved to be right, is the most important of all, not only in things of natural philosophy but in every department of daily life."

The lecture was a profession of the attitude of mind in which he had accomplished his work.

Taking courage to speak boldly, in the presence of your Grace, I would say that even the world of science, to-day, is in great need of following counsel such as Faraday gave in his incomparable lecture. We are too prone to speculate—often too inconsiderate in speculation—too little alive to our own individual ignorance—

[1] Address delivered at the Royal Institution on June 16, the Duke of Northumberland in the chair, at the celebration of the centenary of the discovery of benzene by Faraday

too little bent upon cultivating that breadth of vision and proportionate judgment which is at the root of scientific method. Overcome by the ecstasy of practical achievement, we are too little mindful of the public interest: we are doing too little to make scientific method a public possession. Faraday's dream is in no way fulfilled: the spirit of science in no way enters into our commerce, into our industry, into our public life.

Our best way to praise famous men is to take to heart the lessons of their lives. Consider what Faraday did, at this table, to accomplish the exhortation—"Suffer little children to come unto me." He introduced the Children's Christmas courses and in all his lectures endeavoured to come down to the level of his hearers. How different this from our modern practice—our entirely selfish use of jargon.

We seek to-day to direct attention to Faraday's special greatness as a chemist. He is generally thought of in connexion with electrical discovery but it is significant that he began his career as a chemist: that he grew up in the severity of a proper chemical discipline: just at the time, however, when electricity was coming into vogue. Inspired by his great master, Humphry Davy, fascinated by the wonderful use Davy had made of the electric current in liberating the alkali metals and in discovering the nature of so common a substance as lime, gifted with marvellous power of insight and unhampered by the mass of detail which encumbers our modern thought, he could not do otherwise than recognise the reciprocal inseparable nature of chemical and electrical phenomena. He ultimately proclaimed the essential unity of chemical and electrical change—not yet generally recognised by chemists, though in these days even matter is regarded as of electrical origin. We have yet to acknowledge Faraday's prescience and the consequences of this, his prime discovery.

The range of his chemical activity is astounding, the more when we consider his slender equipment and the fact that he did almost everything himself. As one of the earliest workers in organic chemistry, he stands pre-eminent. He not only discovered the hydrocarbon benzene but also three of the five chlorides of carbon; moreover he was the first to study the sulphonic acids, a class of compound now of the first technical importance. His achievement in making these acids was akin, in principle, to that by which Montgolfier's balloon was changed into the air-ship of to-day, by the introduction, into the car, of the internal combustion engine with its propeller. Naphthalene is an unwieldy hydrocarbon which floats upon water but cannot swim in it, being insoluble—Faraday, by introducing the elements of sulphuric acid, made it soluble and mobile. The discovery has been of infinite service in the dyestuff industry. Faraday was one of the first to examine caoutchouc. His name is associated, for all time, with the liquefaction of the gases. He also studied alloys of iron, optical glass and gold in the finely divided state—each an inquiry of major consequence. Many minor issues were examined, always with perspicacity.

The discovery upon which we base this commemoration, that of benzene, will always rank as one of the most fundamental discoveries of chemistry. If not the entire hub of the organic section of our chemical universe, benzene is at least a major part thereof. Our edifice, in fact, has two foundation stones: one, the simple carbon atom, which can be extended endlessly, as links are, in a chain, the other, a closed complex unit or block of six carbon atoms, ranged as in the diamond and associated symmetrically with six atoms of hydrogen. This latter we call benzene. It is, in fact, just a bit of diamond, mounted and preserved in hydrogen, as though this were *aspic*. The beauty of the diamond, however, is as nothing compared with that of benzene in the eyes of its many mistresses.

Faraday separated benzene from the products of the decomposition of oil by heat. He seems to have taken an interest in these products so early as 1818 but did not come into possession of the material for their study until April 26, 1825. Beginning the investigation on this date, he soon isolated benzene and may be said to have discovered it on May 24, the day on which he first determined its composition, by an operation itself a wonderful experimental "tour de force", the memoir in which he submitted his discovery to the Royal Society is dated June 16. Having studied a material such as he used and knowing its complexity, I marvel at the rapidity with which he carried out the inquiry and the accuracy of his deductions. It is a work of astounding genius.

In those days, formulæ were scarce known. Dalton had but recently put forward his atomic theory. Faraday, however, was already alive to their use and called his product bicarburetted hydrogen, C_2H, the value then assigned to carbon being half the present value. He gives the data for the molecular formula, C_6H_6, though molecular formulæ were unthought of then. About ten years later, the hydrocarbon was prepared from benzoic acid, by Mitscherlich, who altered the name to *benzin*, which Liebig changed to *benzol*. Later (1834), the systematist Laurent introduced the use of the terminal *ene* (ène); alternatively, he proposed the name *phéne* (from φαίνω, to shine), whence phenyl.

The classic academic event in the history of benzene

was the introduction by Kekulé, in 1860, of the conception of a closed system of carbon atoms typified by the world-renowned hexagonal formula. He has told us how the idea first came to him when going home to his lodgings on the top of a London bus. Since then, benzene and its derivatives have been the subject matter of a vast volume of inquiry by all the nations. German chemists, however, were long the leaders.

Attention was first specially directed to the presence of benzene in coal tar in 1845. The process of extracting it was devised, in 1849, by Mansfield, working in Hofmann's laboratory in Oxford Street, London. To-day, the gases formed on heating coal to redness, either in manufacturing town's gas or metallurgical coke, are most carefully stripped of benzene and allied hydrocarbons. Our output of "crude benzol" is estimated at 22,000,000 gallons, which is mostly used as motor fuel. Certain petroleums contain considerable quantities of benzene hydrocarbons.

Benzene only acquired technical importance from 1856 onwards, when our countryman, William Henry Perkin, entered upon his great adventure, at the age of nineteen. He not only discovered the first aniline colour, mauve: he also founded the artificial dyestuff industry. To-day, the natural colouring matters are all but displaced by dyestuffs, often superior, derived more or less directly from benzene.

Nothing that has happened since Faraday made his discovery would have given the philosopher greater pleasure than the advance in our knowledge of the origin of colour—a subject which once filled his mind. Turning to his remarkable correspondence with the Swiss chemist, Schonbein, whose name comes next to those of Priestley and Lavoisier in the history of oxygen, we find Schonbein, in a letter dated Oct. 17, 1852, writing to him as follows:—

"Entertaining the notion that in many, if not in all cases, the colour exhibited by oxycompounds is due to the oxygen contained in them or, to express myself more distinctly, to a peculiar chemical condition of that body, I have continued my researches on the subject and obtained a number of results which I do not hesitate to call highly curious and striking . . . I am nearly sure that you will be pleased to repeat the experiments, for either by mere physical means or by chemical ones you may make and unmake or change the colour of a certain substance without altering the chemical constitution of those matters. To my opinion, that wonder is performed by changing the chemical condition of the oxygen of the oxycompound."

To this Faraday replied on December 8:—

"Your letter quite excites me and I trust you will establish undeniably your point. It would be a great thing to trace the state of combined oxygen by the colour of its compound, not only because it would show that the oxygen had a special state, which could in the compound produce a special result—but also because it would, as you say, make the optical effect come within the category of scientific appliances and serve the purpose of a philosophic induction and means of research, whereas it is now simply a thing to be looked at. Believing that there is nothing superfluous or deficient or accidental or indifferent in nature, I agree with you in believing that colour is essentially connected with the physical condition and nature of the body possessing it and you will be doing a very great service to philosophy if you give us a hint, however small it may seem at first, in the development or, as I may even say, in the perception of this connexion."

Before you are two specimens, one of quinol, the other of quinone, one colourless, the other coloured—yellow. Quinone is the type of all organic colouring matters. In quinol, the simple molecule of water, H·O·H, less an atom of hydrogen, is introduced twice into benzene, in place of two of its atoms of hydrogen: it is colourless. Remove from it two atoms of hydrogen, one from each of the two OH groups: the product, quinone, is yellow in colour. It is as Faraday supposed: the condition of the oxygen is altered and certain centres in the molecule become active absorbents of the light waves.

I have ventured to hang upon the inward wall of this great fortress of science, which Faraday occupied to such wonderful purpose, "a banner sable, trimmed with rich expense," bearing a strange device emblematic of benzene. Faraday's initial is enclosed within the hexagon which symbolises his discovery. This symbol is one that we may aver will last for all time, as upon it may be welded all the facts relating to benzene. It is probably the most significant symbol ever devised, for it has veritable volumes of meaning in the chemist's seeing eye. From it the colours irradiate—though not precisely in prismatic order. Colour, at its first appearance, is either yellow or blue, according to the type of compound, yellow being always associated with simplicity of type. As molecular complexity is raised, yellow is gradually intensified and passes into the richest red. Blue, in like manner, becomes intensified and may pass into green, which is the forerunner of black. The changes are due either to changes in the weighting of the absorbing centres or to their cumulative repetition and co-operative action.

Behind me is a curtain of wondrous texture and colour, dyed with *Jade green*, one of the latest and most valuable, certainly the most remarkable of the anthracene vat-colours: it was first made in Scotland. Mark its symbol—it is benzene soldered upon benzene, many times over: a *Nonaphene*. The two lone, unsociable, oxygen atoms are the main cause of its colour. Note the wonderful change in colour when these oxygen

atoms are wedded each to an atom of hydrogen—now the *Jade green* becomes a salmon-red, with a most remarkable fluorescent sheen, indicating a simplification of the light-absorbing mechanism. The big hank of viscose silk across the green curtain is dyed with the material in which the green has been thus wedded hydrogen: if oxygen be allowed to take away the hydrogen, the dyestuff again becomes green, may we not say, with envy. Note also this intensely blue hank. In *Jade green* the oxygen atoms are related as are my thumbs when I so juxtapose my fingers that the backs of my two hands are in the same plane. Turning one hand round, my thumbs become related diagonally. Making a like change in the molecule of *Jade green*, converting the dibenzanthrone into isodibenzanthrone, the colour passes into blue: wed the oxygen with hydrogen, it passes into red of a blue shade. We can picture what would have been Faraday's and Schonbein's ecstasy of delight at seeing their prophecy verified in such chameleon-like behaviour.

I have referred to Viscose silk. What would Faraday have said, if told that we had not only found "tongues in trees" and gone far to discover "good in everything" but also that, spider-like, we had made the mere timber of trees into a veritable silken web, carrying colours of every hue made from his benzene, a material found worthy of notice even by a Chancellor of the Exchequer and actually worn not by Queens alone but also by most of their female subjects? Could we tell him these things, might he not well ask what is left for poor Nature to do: at the same time, he would be the first to recognise that we had studied "natural things" to some purpose and had he foreseen the power chemists were to wield over Nature, he would perhaps have elected to remain a chemist and have thought little of electricity—as do chemists to-day.

We may go further still in tracing the scientific progress of benzene. It is written that "the last shall be first." Benzene, however, retains its dominance and is everlasting. The discovery of the first Fullerian professor, benzene and its descendants are now the objects of most serious attention by the latest holder of the chair. Racked upon his goniometer, tortured by X-rays, they are being forced to disclose the secrets of their inmost atomic centres: their molecular dimensions are being determined in ultramicroscopic terms. Faraday would not have been surprised: he would have been the first to welcome such achievements but with reverence, as well as delight at our progress.

By some uncanny mental process, the chemist has prophesied what X-rays are justifying; and now a new era is upon us, one for which we must prepare ourselves. Like Faraday, we must have many-compartmented minds. We must learn to think in the solid. The chemistry of the future will be spatial in dimensions and distribution. It will be in no slight degree a science of solid geometry. I have here a model of benzene in terms of units such as X-rays reveal to us in the diamond. Mr. William Barlow and I desire to lay this to-day upon Faraday's table as a solid tribute to his memory: it is something more than a mere symbol: we believe it to be a very close approach to the geometrical structure of the molecule It is something I have hoped for during the whole of my life. There are other models here, made by Mr. Barlow, of various derivatives of benzene, all in close accordance with crystallographic data.

To return to colour, the colour-chemist to-day is a super-magician. If women could be scientific, they would insist upon being stamped all over, not with a king's cartouche, such as we have seen was used on Tut-ankh-Amen's tomb, no, with the hexagon symbol of benzene, as the emblem of the colours in which they are now arrayed far more gloriously than were ever the lilies which Solomon, we are told, could not rival. To-day, we can paint the lily with its own colour We make the colours of the lily, indeed those of most flowers, in the laboratory, actually from benzene. Faraday, in Sandemanian moments, would almost have regarded this as sacrilege.

To-day is no common occasion and we desire to deal with it in no common way. This commemoration is held at the instance of a remarkable and unusual conjunction: by the Royal Institution, acting together with the Chemical Society, the Society of Chemical Industry and the Association of British Chemical Manufacturers—a trinity completely representative of English chemical interests. Chemists desire to show that for once they can think together We together acclaim the memory of Faraday—of Faraday the complete philosophic chemist. Moreover, our committee has decided to take in hand the preparation of a medal, to be awarded at intervals, perhaps sexennially, without regard to nationality, for an outstanding achievement in some clear relation with Faraday's discovery of benzene. We desire not only to keep his influence alive but also to extend it. We propose to follow a well-known practice of the clergy and make the first award, in anticipation, to-day. We ask Mr. James Morton, of Carlisle and Grangemouth, to accept promise of the first Faraday Benzene Centenary Medal, in special recognition of the signal service he has rendered to chemical science and industry in Great Britain, during the past ten years, by developing and extending the manufacture of the anthracene vat-dyestuffs and, more recently, by extending their application to silk and wool.

Faraday and his Contemporaries.[1]

By Prof. Ernst Cohen

YOU all know Lord Byron's reply to the malignant diatribe on his "Hours of Idleness," published by the *Edinburgh Review*, the slating critique which advised him "that he do forthwith abandon poetry, and turn his talents, which are considerable, and his opportunities, which are great, to better account."

Some years afterwards Byron himself admitted that he had gone too far in his "English Bards and Scotch Reviewers," saying "The greater part of this satire I most sincerely wish had never been written, not only on account of the injustice of much of the critical and some of the personal part of it, but the tone and temper are such as I cannot approve." Not only did he attack in this most vehement effusion the achievements of English literature, but also he fretted and fumed about those produced by contemporary science

"Thus saith the Preacher 'Nought beneath the sun
Is new, yet still from change to change we run,
What varied wonders tempt us as they pass!
The cow-pox, tractors, galvanism, and gas,
In turns appear, to make the vulgar stare,
Till the swoln bubble bursts—and all is air!'"

The word "tractor" wants explanation, as its meaning differs from that which it has to-day

About the year 1790 an American physician, Dr Elisha Perkins, invented an instrument, which he named "metallic tractors," for the cure of local pains, inflammations, and rheumatism. The tractors, he claimed, were of peculiar and secret composition, but it is asserted that one was of iron, the other brass. They were three inches long and pointed. In use they were drawn downward over the affected part of the patient for twenty minutes. Dr. Perkins' son published a book in London, introducing the method, and it inspired so much faith that a Perkinsian Institution was opened, of which Lord Rivers was president. Recommendations were signed by many physicians and clergymen and thousands of cures published, so that the inventor pocketed a considerable sum of money. Heated discussions arose, and James Gillray, the celebrated caricaturist, lampooned the matter in his production "Metallic Tractors," where Dr. Perkins is seen trying to restore, by means of his instrument, the normal shape of the nose of a drunkard.

That Byron had been absolutely wrong so far as gas bubbles are concerned is evident from the most interesting addresses we had the good fortune to hear a few moments ago, as gas was the material to which we owe Faraday's wonderful discovery of the foundation-stone of a major section of organic chemistry and of the synthetic dye-stuff industry.

If Byron had been right where he mentions Dr. Jenner's magnificent invention, what would have been to-day the aspect of this assembly?

Allow me to remind you in this place where chemists from all parts of the world are gathered to-day to do homage to the memory of one of the most admirable geniuses, of one of the most noble characters England ever produced, that Byron continued his comedy of errors when he ridiculed the achievements with which Galvani and Volta as well as Humphry Davy had presented natural philosophy. This can scarcely be done in a more striking way than by resuming, be it only in a few words, what the human race owes to Michael Faraday in his capacity of a physical chemist, especially in that branch of our science which was so mercilessly attacked by the author of "English Bards and Scotch Reviewers."

Two years after the discovery of benzene, Faraday published his "Chemical Manipulation." This title is far too narrow, as we have to deal with an almost complete laboratory companion for physico-chemical work. In none of our contemporary books on this subject is so much stress laid upon the necessity of cleanliness in laboratory work, none of them gives so strong evidence as Faraday's manual that Peter Riess was absolutely wrong in his definition of chemistry:

[1] Address delivered at the Royal Institution on June 16, the Duke of Northumberland in the chair, at the celebration of the centenary of the discovery of benzene by Faraday.

"Die Chemie ist der unreinliche Teil der Physik," which runs in plain English: "Chemistry is the dirty part of physics." Every page of this most valuable book not only shows the author's passion for his subject, but at the same time his extraordinary skill as an experimenter, who tries to perform the operations, when desirable, with the smallest number of requisites. Years afterwards this faculty of Faraday's was symbolised by a most charming cartoon of *Punch* with this legend: "Faraday giving his card to Father Thames; and we hope the Dirty Fellow will consult the learned Professor." The adjoined text runs as follows:

"A Philosopher Afloat.

"A chemical work of small size and great importance has been lately published. The production alluded to is Faraday on the Thames, a title which means even more than it appears to mean; for it not only expresses Professor Faraday's views of the composition of the river, but also describes the sensations experienced by him during a period of brief transit upon its surface. A piece of white card, according to the professor, becomes invisible at a very small degree of submersion in the Thames water, which is of a peculiar colour—'opaque pale brown'-drab-quakerish—and a not very peculiar smell, because it partakes of that of the sink-holes, and may be described as odoriferous, but not fragrant. We have often had great pleasure in hearing Faraday explain the composition of water, pure and simple; but we rejoice much more that he has enabled the public to form a correct idea of the constituents of that of the Thames, which consists of something more than Oxygen and Hydrogen. Because we are losing brave men by war, it is rather the more desirable than otherwise that we should not also lose useful citizens by pestilence, as we certainly shall if the Thames continues much longer to be an open sewer. We hope that Professor Faraday's publication, which takes the shape of a concise letter to the *Times*, will effect a saving of human life still greater than that which has resulted from his predecessor's safety-lamp. Davy's invention prevents carburetted hydrogen from blowing up miners; may Faraday's epistle avert cholera and typhus by stirring up senatorial and municipal persons to prevent sulphuretted hydrogen from being disengaged."

In the year 1830 an event occurred in Great Britain which is to be considered as unique in the history of science. Let me tell you this historical story, as I did some time ago on another occasion.

Charles Babbage, then a professor in the University of Cambridge, published a small pamphlet, "Reflections on the Decline of Science in England and on some of its Causes," in which he tried to prove that England was, with respect to the more difficult and abstract sciences, not only below other nations of equal rank, but even below several of inferior power. It should be mentioned that this opinion did not remain unnoticed abroad. A short time afterwards a reply was published to Babbage's book. Its title was, "On the Alledged Decline of Science in England," by a *Foreigner*. Now I found that this foreigner was Dr. Moll, then a professor of physics in the University of Utrecht. It may interest you also that I found that Faraday, who was an intimate friend of Moll's, paid the publishing expenses, Moll being unable to find a publisher. The Utrecht professor proved that Babbage was wrong. Here you see on the screen a caricature of the time, with the legend: "Dedicated (but not), with permission, to the British Association for the Advancement of Science." I have been able to prove that the men pictured represent Moll and Dalton meeting at the Royal Institution of Edinburgh, Dalton expressing thanks to Moll for having defended British Science. The name of the author of this picture, who hides behind the initials X Y Z, is unknown up to the present

Even to-day it can scarcely be understood how Babbage could express such an unfavourable opinion at a period when such a brilliant array of British names had become immortal by scientific labours. As if Faraday had cherished the desire to give the lie to Babbage's arguments, a few years later he presented science with the discovery of those wonderful laws which for all times will form the base of the theory of electro-chemistry. Do not suppose that this achievement was immediately unanimously applauded I find in a letter of Berzelius to his friend Wohler, written some months after the publication of Faraday's celebrated paper: "I have got Faraday's sixth and seventh paper and read his discovery of definite proportions of electricity, which has been so greatly extolled in England. It covers 4 sheets of printing, and is devilishly hard to read. Besides this the conceptions developed in this purely theoretical paper are so narrow that it declines very strongly my former opinion of Faraday." But some months later Berzelius again changed his mind, and in his review of Faraday's investigations, published in his *Jahresbericht* of the year 1835, he wrote these sentences: "As a matter of fact, Faraday created by his meritorious investigations the possibility of founding our theoretical conceptions on a more reliable base."

To-day we know that there scarcely exists any natural law which holds good within such wide intervals of concentration, temperature, and pressure as those discovered by this hero of science. From the chemical point of view it is to be emphasised that his investigations, which culminated in the demonstration that equivalent quantities of substances have equal quantities of electricity associated with them, disproved, once and for all, the Berzelian hypothesis that a greater quantity of electricity is needed to separate

a compound of a very positive with a very negative element, or radical, than is required to separate a compound of a less positive with a less negative element, or radical. But, at the same time, Faraday's researches strengthened that part of the Berzelian doctrine which asserted the existence of a close connexion between electrical and chemical forces

Looking to-day at Faraday's words: "The electricity of the voltaic pile . . . is entirely due to chemical action, and is proportionate in its intensity to the intensities of the affinities concerned in its production, and in its quantity to the quantity of matter which has been chemically active during its evolution," we immediately recognise in them the roots of the magnificent development which the doctrine of chemical affinity has shown since those times by the labours of Willard Gibbs, von Helmholtz, and van 't Hoff. While the whole of the present electric industry is based on Faraday's discoveries in the fields of converting electric energy into mechanical power or, reciprocally, of obtaining electric energy by an expenditure of mechanical work, electro-chemical industry owes its existence to his far-reaching researches in the field of chemistry.

It would be carrying coals to Newcastle to give here an account of the influence of these achievements upon our purely theoretical conceptions and upon the conveniences of modern life, which could never have been dreamed of by our ancestors. Recalling this to mind, we cannot but repeat Shakespeare's words:

"He was a man, take him for all in all,
I shall not look upon his like again."

The Royal Institution.

NEW HONORARY MEMBERS.

THE proceedings at the centenary celebrations at the Royal Institution were marked by the presentation of diplomas of honorary membership to six distinguished foreign chemical workers. The presentations were made by the president of the Institution, His Grace the Duke of Northumberland, and the recipients, two of whom were represented by fellow-countrymen who were able to be present, were introduced by the secretary of the Institution, Sir Arthur Keith, in the following words:

GABRIEL ÉMILE BERTRAND, professor of biological chemistry at the Sorbonne, Paris, and Director of the Laboratory of Biological Chemistry at the Institut Pasteur. Prof. Bertrand is distinguished as an inquirer into bacterial activity, particularly in connexion with oxidation phenomena, of which he has made a special study. He has also paid great attention to the influence of minute quantities of metals not usually regarded as acting upon the course of vital change.

ERNST JULIUS COHEN, professor of general chemistry and inorganic chemistry, University of Utrecht, Holland. Prof Cohen is an acknowledged leader in physical chemistry, the biographer in England of his master, Van 't Hoff, and like him, a devoted student of Byron

PIERO GINORI-CONTI, Senatore, president Associazione Italiana de Chimica, Generale ed Applicata, Rome, Italy. Prince Ginori-Conti has acquired distinction by capturing natural steam and using it as a source of energy, at the same time extracting from it large quantities of boric acid. He manufactures perborates from this latter by Faraday's method of electrolytic oxidation

JAMES FLACK NORRIS, professor of organic chemistry, Massachusetts Institute of Technology, and secretary of the American National Research Council. Prof. Norris is president of the American Chemical Society, a constituency of 15,000 chemists. He is professor in the most noted of American Technical Schools, the Massachusetts Institute of Technology, and himself a well-known original worker

JOJI SAKURAI, president of the Japanese National Research Council, emeritus professor, Imperial University of Tokyo, Japan, and member of the Japanese House of Peers Prof. Sakurai was a student under the late Prof A. Williamson at University College, London, one of the first small band of Japanese students who came to Europe to acquire a knowledge of western science. Working upon foundations laid by the late Prof. Divers, he has long been noted as the inspiring mind in Japanese chemistry. A founder of the National Research Council of Japan, he is now actively engaged in promoting the application of science generally in his country.

FREDERIC SWARTS, professor of chemistry, University of Ghent, Belgium, and member of the Royal Academy of Belgium Prof. Swarts is the son and successor of the successor of Kekulé in Gand. His father was Kekulé's assistant at the time (1868) Sir James Dewar worked in Gand, together with Körner, celebrated as the first to disclose the value of Kekulé's benzene symbol. Prof. Swarts is distinguished as a student of the organic compounds of fluorine.

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*

I. A. R. I. 75

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